"NATIONAL" PIPE STANDARDS

Of the Appendix to 1913
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PREFACE TO APPENDIX

For a number of years National Tube Company has been publishing, at intervals, informatory, educational literature in various forms which has a widely acknowledged value, as evidenced by the constantly increasing requests from technical and practical engineers, mechanical men, manufacturers, students and many others interested in pipe and allied products.

Much of the data will not be found elsewhere, for it represents years of research work in the mills and laboratories of this company; years of careful investigation of results of various materials installed under identical conditions of service, and in addition the reports made by unbiased authorities in the course of their service investigations.

While each publication of National Tube Company is as complete in its proposed scope and purpose when it comes from the press as it is possible to make it, yet as soon as it is ready for distribution new data for a new edition begins to accumulate, for something new in manufacturing processes, or in application or use of material is constantly developing in the mills or in the general field.

It will be appreciated, therefore, that no National Tube Company literature can be considered complete, final, and unchangeable. The 1913 edition of the Book of Standards has proved most satisfactory and valuable to those who use it, but it is now three years old, and a mass of additional information has become available.

The purpose of this Appendix is to supply the latest information on the subjects contained in the 1913 Edition Book of Standards. For the most part this information is supplementary, but in several cases it replaces other data entirely. Where there seems any conflict between the two, the information contained in this Appendix is to be considered as the later information.

The Index in this Appendix (which embraces both the Appendix and original Book of Standards) should be used in place of that in the 1913 Edition Book of Standards.

"NATIONAL" PIPE STANDARDS

Appendix to 1913 Edition

Book of Standards

Containing Tables *and* Useful Information Pertaining to Tubular Goods as Manufactured by

National Tube Company

Pittsburgh, Pa.

NATIONAL TUBE COMPANY

Pittsburgh, Pa. Nineteen Hundred and Sixteen

LIST OF PRODUCTS OF NATIONAL TUBE COMPANY

There has been a constant and increasing demand for a concise list of the products manufactured by National Tube Company, and in order to supply a quick and ready reference to meet this demand, a list of the three classes of products has been compiled, under the following divisions:

1. "NATIONAL" PRODUCTS.
2. "SHELBY" SEAMLESS TUBING PRODUCTS.
3. "KEWANEE" PRODUCTS.

"NATIONAL" PRODUCTS

"NATIONAL" Pipe is made by one of two processes: butt-weld or lap-weld. All sizes up to and including 1¼-inch are made by the butt-weld process; sizes 1¼-inch up to 3-inch are made by either process; and all sizes above 3-inch are made by the lap-weld process only.

A list of the various kinds of "NATIONAL" Pipe and allied products follows:

"NATIONAL" Air Line Pipe.
" Allison Vanishing Thread Tubing, Ends Upset.
" Allison Vanishing Thread Tubing, Ends Not Upset.
" Ammonia Cylinders.
" " Pipe, Re-drawn or Lap-welded.
" Bailer Tubes.
" Bedstead Tubing.
" Boston Merchant Casing.
" " Casing, Inserted Joint.
" " Oil Well Casing.
" " " " " Pacific Couplings.
" Bump Joint Pipe.
" California Diamond BX Casing.
" " " " Drive Pipe.
" " Special External Upset Tubing.
" Converse Lock Joint Pipe.
" Double Extra Strong Pipe.
" Drill Pipe.
" Drive Pipe.
" " Well Pipe.
" Dry Kiln Pipe.
" Extra Strong Pipe.
" Flush Joint Tubing.
" Gas Line Pipe.
" Grip or Grief Pipe.
" Hydraulic Pipe.
" Kimberly Joint Pipe.
" Large O. D. Pipe.
" Line Pipe.

[Th]is information supplements that on pages 4, 7, 81

"NATIONAL" Locomotive Arch Pipes.
" " Bridge Pipes.
" " Dry Pipes.
" " Water Grates.
" Matheson Joint Pipe.
" Mattress Tubing.
" Oil Line Pipe.
" " Well Tubing.
" Pipe for Air Brakes.
" " Asphalted.
" " for Bending.
" " Black.
" " Butted and Strapped Joint.
" " Coated.
" " for Columns.
" " " Elevator Plungers.
" " " Fence Posts.
" " Fitted with Patent Recessed Couplings.
" " for Flanging.
" " Galvanized.
" " for Heaters.
" " with "NATIONAL" Coating.
" " for Ocean Piers.
" " " Paper Cores.
" " " Piling.
" " " Pump Sets.
" " " Sign Posts and Mail Boxes.
" " " Stay Bolts.
" " Tar Dipped.
" Plain End Pipe for Gas Lines.
" Reamed and Drifted Pipe, Black.
" " " " " Galvanized.
" Rectangular Pipe.
" Selected Oil Line Pipe.
" "SHELBY" Seamless Interior Upset Drill Pipe.
" Signal Pipe.
" Special Rotary Pipe.
" " Upset Rotary Pipe.
" Spellerized Locomotive Boiler Tubes.
" Square Pipe.
" Standard Boiler Tubes.
" Tubular Steel Bridge Warning Poles.
" " " Flag Poles.
" " " " Staffs.
" " " Poles for Electric Power Lines and Lights.
" " " " " Telegraph and Telephone Lines.
" Tuyere Pipe.

This information supplements that on pages 4, 7, 21

"SHELBY" SEAMLESS TUBING PRODUCTS

The following list outlines briefly the variety of products offered to the trade in "SHELBY" Seamless Tubing. (Further information regarding any of these products or shapes, or special shapes desired, can be secured by addressing any district office of National Tube Company.)

"SHELBY" Seamless Arch Pipes.
" " Automobile Tubing.
" " Axles.
" " Bedstead Tubing.
" " Bicycle Tubing.
" " Blau-Gas Cylinders.
" " Boiler Tubes, Upset, Expanded, and Swaged Ends.
" " Bridge Pipes.
" " Carrier Tubes.
" " Carbonic Acid Gas Cylinders.
" " Chandelier Tubing.
" " Cold Drawn Tubing.
" " Compressed Air Tubing.
" " Condenser Tubing.
" " Cream Separator Bowls.
" " Cyclecar Tubing.
" " Cylinders for Special Designs and Purposes.
" " D Shaped Tubing.
" " Die Stock Handles.
" " Display Fixture Tubing.
" " Drill Pipe.
" " " Rod Tubing.
" " Dry Pipes.
" " Expanded Ends Tubing.
" " Formed Tubes, Special Designs, for Automobiles, etc.
" " Gas Cylinders.
" " Gravity Carrier Tubing.
" " Hexagon Tubing.

is information supplements that on pages 4, 7, 14

"SHELBY" Seamless Hollow Shafting.
" " Hose Poles or Mandrels.
" " Hot Rolled Tubing.
" " Large Diameter Tubing.
" " Liquefied Gas Cylinders.
" " Locomotive Boiler Tubes.
" " Mechanical Tubing.
" " Motorcycle Tubing.
" " Marine Boiler Tubes.
" " Non-Liquefied Gas Cylinders.
" " Octagon Tubing.
" " Oval Tubing.
" " Oxygen Gas Cylinders.
" " Pneumatic Tube Service Tubing.
" " Poles.
" " Pump Tubing.
" " Rectangular Tubing.
" " Rope Tubing.
" " Round Tubing.
" " Safe Ends.
" " Shafting, Hollow.
" " Square Tubing.
" " Stationary Boiler Tubes.
" " Stay Bolt Material.
" " Steam Feed Piston Tubing.
" " Superheater Tubes.
" " Swaged Tubing.
" " Tanks.
" " Telephone Stand Tubing.
" " Tempering Pots.
" " Trolley Poles.
" " Tubes, Marine, Stationary and Locomotive Boiler.
" " Tubing for Mechanical Purposes.
" " Upset Tubing.
" " Water Grates.
" " Wrist Pin Tubing.

This information supplements that on pages 4, 7, 14

"KEWANEE" PRODUCTS

Probably the best known of the "KEWANEE" Specialties is the "KEWANEE" Union. In addition to the union, however, the now famous "KEWANEE" principle has been adapted to valves and other fittings. For description of these specialties see "The Whole 'KEWANEE' Family" booklet, or Catalog J-1915, both of which are published by this company and furnished without charge to those whose activities indicate a legitimate use for same.

The "KEWANEE" Specialties, the entire line of "N. T. C." Regrinding Valves, brass and iron body valves, and the full line of brass, cast iron, malleable, and wrought fittings, are listed below in alphabetical order:

Acid Cocks.
" Fittings.
" Valves.
Air Brake Fittings, Malleable.
" Cock, "NATIONAL" Spring Plug.
" Cocks, Lock and Shield.
Artesian Well Cylinders, All Brass.
" " " Barrel Brass Lined.
" " Strainers.
Base Fittings, Flanged.
Beam Clamps, Adjustable.
" Hooks.
Bends, Casing, Malleable.
" Cast Iron, Car Heater.
" Return, Back Outlet.
" Standard and Extra Heavy.
Blast Furnace Fittings.
" " Supplies.
Blind Flanges.
Boiler Couplings, Circulating, "KEWANEE."
" " " Malleable.
Box Coil Tees.
" Coils, Ornamental and Plain.
Boxes, Brass Stuffing.
Bracket Coils.
" Ells and Tees.
Branch Tees.
Branches, Cast Iron Y.
" Malleable Y.
Brass Wire Cloth, New and Renovated.
Bremer Checks, Tubular Well Valves.
Brine Cocks.
Bull Head Tees, Cast Iron, Standard and Extra Heavy.
Bushings, Brass.
" Cast Iron.

Bushings, Cast Iron Casing.
" " " Eccentric, Reducing.
" Malleable.
" " Faced.
" " Reducing.
" " Radiator.
Caps, Brass.
" Cast Iron Casing.
" " " Extra Heavy.
" Malleable Drive, Round and Octagon.
" Plain, Beaded and Hexagon.
Car Heater Fittings.
Casing Bushings.
" Caps.
" Clamps.
" Fittings.
" Nipples.
" Saddles.
Cast Iron Fittings, Standard and Extra Heavy.
" " " Flanged.
" " " Long-Sweep.
" " " Reducing.
" " " Screwed.
Ceiling Plates.
Check Valves, Adjustable.
" " Brass.
" " " with Drip Cock.
" " " Horizontal.
" " " Jenkins Disc, "N. T. C." Special Pattern Horizontal.
" " " with "KEWANEE" Union.
" " " "N. T. C." Regrinding.
" " " Swing.
" " Iron Body.
" " " " Angle and Vertical.
" " " " Horizontal.
Chandelier Hooks and Loops, Malleable.
Clamps, Beam.
" Double Strap, Wrought.
" Hydrant.
" Pipe, Steam.
" " Water.
" Service.
Cocks, Brass, Acid.
" " Air, Lock Shield.
" " Brine.
" " Check and Waste.
" " Gas Meter.
" " " Service.

Cocks, Brass, Gas Service, Bar Pattern.
" " " " Boston Pattern.
" " " " with "KEWANEE" Union.
" " " " Natural Gas.
" " Hydrant, Screwed.
" " Lock and Shield.
" " Rough, Stop.
" " Tuyere.
" " Union Meter.
" "NATIONAL" Spring Plug.
" Iron for Alkaline Solutions.
" " with Brass Plug.
" " " " Washer.
" " Extra Heavy.
" " Oil Country.
" " Service.
" " Three Way.
Coil Stands, Laundry.
Coils, Bracket.
" Steam Box, Plain and Ornamental.
Columns, Water.
Companion Flanges, Cast Iron, Malleable and Brass.
" " Blind, Ribbed and Plain.
" " Flanged and Reducing.
Couplings, Malleable, Cast Iron and Brass.
" Beaded, Right and Left Only.
" Boiler, "KEWANEE."
" Car Heater.
" Casing.
" Circulating Boiler.
" Drill Rod.
" Drive Pipe.
" Eccentric.
" Faced.
" Hexagon.
" Hose.
" for Iron Rods, Beaded.
" Long Screw.
" Offset.
" Patent Sleeve Tubing.
" Pipe.
" Pump Rod.
" Recessed.
" Reducing.
" Right and Left.
" Tool.
" Tubing.
" Turned.
" Union Boiler.

Couplings, Water.
" Wood Rod.
" Wrought.
Cross-overs, Malleable.
" " Back Outlet.
Crosses, Malleable, Cast Iron and Brass.
" Casing.
" Flanged.
" Hub End.
" Hydraulic.
" Long Sweep.
" Plain and Beaded.
" Railing.
" Reducing.
" Screwed.
" Side Outlet.
" Standard and Extra Heavy.
" Sweep.
Cylinders, Brass, Eureka, Tubular Well.
" Brass Lined, Artesian Well.
" " " Tubular Well.
" Wrought, Tubular Well.
Drive Caps, Malleable, Octagon and Round.
" Shoes, Malleable.
" Well Points, Brass Jacket.
" " " Extensions.
" " " Flush or Tubular.
" " " Large Size, Railroad.
" " " " " Water Works.
" " " Open Center, Banner.
" " " Scott Perfection.
" " " Single Screen.
" " " Washer.
Elbows, Brass.
" " Drop.
" " 45 Degree.
" " Finished.
" " Radiator.
" " Railing.
" " Reducing.
" " Right and Left.
" " Side Outlet.
" " Street.
" " Union.
" " " for Radiators.
" Cast Iron and Malleable.
" " " " " Standard and Extra Heavy.
" Cast Iron, Flanged and Screwed.
" Base, Square and Round.

Elbows, Boiler, "KEWANEE."
" Car Heater.
" Casing.
" Cleanout.
" Double Branch.
" Drop.
" 45 Degree.
" Hydraulic.
" "KEWANEE" Union.
" Long Sweep.
" Pitched.
" Radiator.
" Railing.
" Reducing.
" Side Outlet.
" 60 Degree.
" Street.
" Taper Reducing.
" Union.
Expansion Joints, Brass and Iron Body, Flanged and Screwed.
" Pipe Hangers.
" Plates.
Extension Pieces.
Fittings, Cast Iron, Malleable and Wrought.
" Standard, Extra Heavy and Hydraulic.
" Brass, Steam, Rough and Finished, Wrought Pipe Size.
" " Hydraulic.
" " Railing.
" Air Brake.
" " Tested.
" Base.
" Boiler.
" Bushings.
" Caps.
" Car Heater.
" Casing.
" Couplings.
" Crosses.
" Eccentric.
" Elbows.
" Flanged.
" Flanges.
" Hydraulic.
" "KEWANEE."
" Laterals.
" Locknuts.
" Nipples.
" Offsets.
" Plugs.

This information supplements that on pages 4, 7, 167 to 182

Fittings, Railing.
" Reducers.
" Return Bends.
" Sprinkler.
" Sweep.
" Tees.
" Unions.
" Water Connections.
Flanged Fittings, Cast Iron, Standard and Extra Heavy.
" " Crosses, Reducing.
" " Double Branch Ells.
" " " " Reducing.
" " " Sweep Tees.
" " Elbows Long Sweep.
" " " Base.
" " " Side Outlet.
" " " Taper Reducing.
" " Four Way Tees.
" " 45 Degree Ells.
" " Laterals, Long Sweep.
" " Reducers.
" " Taper Reducers.
" " Tees.
" " " Reducing.
" " " Single Sweep.
" " Y's.
" Valves, Brass Gate, Globe and Angle.
" " " Check, Horizontal, Swing, Vertical.
" " Iron Body Gate, Globe, Angle and Check.
Flanges, Brass, Cast Iron and Malleable.
" Blind Faced.
" Bolted On.
" Common.
" Companion.
" Curved.
" Eccentric.
" Faced and Drilled.
" Floor.
" Grooved.
" Male and Female.
" Railing.
" Raised Face.
" Recessed.
" Reducing.
" Saddle.
" Solid.
" Spot Faced, Bolt Holes.
" Tongued.
" " and Grooved.

Flanges with Caulking Recess.
Floor Plates.
Followers, Long Screw.
Foot Elbows and Tees.
" Valves.
Galvanized Fittings, Cast Iron, Malleable and Wrought.
" " Standard and Extra Heavy.
Gas Cocks.
" Meter Cocks.
" " " with "KEWANEE" Union.
" Service Cocks, Bar Pattern.
" " " Boston Pattern.
" " " Heavy Pattern.
Gate Valves, Brass.
" " " Acid.
" " " Automatic Drip.
" " " Differential Stem Thread.
" " " Double Disc.
" " " Hose.
" " " "KEWANEE" Union.
" " " Quick Opening.
" " " Radiator, with "KEWANEE" Union.
" " Iron Body, Converse Joint.
" " " " Electrically Operated.
" " " " "Eurema" Y.
" " " " Flanged.
" " " " Globe and Angle.
" " " " Half Rising Stem.
" " " " Hub End N. R. S.
" " " " " and Spigot N. R. S.
" " " " Matheson Joint.
" " " " N. R. S. Double Disc.
" " " " " Spigot End.
" " " " " Wedge Disc.
" " " " " with By-pass.
" " " " O. S. & Y. Double Disc.
" " " " " Wedge Disc.
" " " " " with By-pass.
" " " " Quick Opening.
" " " " Screwed.
" " " " Swing Check.
" " " " with Spur or Bevel Gear.
" " " " Underwriters' Indicator, Double Disc N. R. S.
" " " " Underwriters' Indicator, Double Disc O. S. & Y.
" " " " Underwriters' Indicator, Screwed and Flanged.
" " " " Wood Pipe.

This information supplements that on pages 4, 7, 167 to 182

Gauge Syphon, Steam.
Globe and Angle Valves, Brass.
" " " " " Acid.
" " " " " Competition.
" " " " " Copper Disc.
" " " " " Jenkins Disc, "N. T. C."
" " " " " with "KEWANEE" Union.
" " " " " Natural Gas.
" " " " " Needle Point.
" " " " " "N. T. C." Regrinding.
" " " " Iron Body, Brass Mounted, Flanged with Yoke.
" " " " Iron Body, Brass Mounted, "N. T. C." Jenkins Disc.
" " " " Iron Body, Brass Mounted, Plain.
" " " " Iron Body, Brass Mounted, with Yoke.
" " " " Iron Body, Flanged "N. T. C." Jenkins Disc.
" " " " Iron Body, Flanged with Yoke.
" " " " Iron Body, Screwed "N. T. C." Jenkins Disc.
" " " " Iron Body, Screwed with Yoke.
" " " " Plain Top with Brass Bonnet.
" " " " " with Lock Shields.
Handles, Hydrant.
" and Wheels for Valves.
Hangers, Pipe Expansion.
" " " "WESTERN."
Hexagon Center, R. & L. Nipples.
" Couplings.
" " for Iron Rods.
" "KEWANEE" Unions.
" Nipples.
Hooks, Beam.
" and Loops, Chandelier.
Hook Plates.
" " Expansion.
Hose Couplings, Brass, Blast Furnace.
" Gate Valves, Brass.
" Unions, "KEWANEE."
" Valves, Brass, Garden.
" " " Gate, with Leather Disc.
" " " Special.
Hydrant Clamps.
" Cocks.
" Handles.
Joints, Expansion, Brass and Iron Body.

his information supplements that on pages 4, 7, 167 to 188

"KEWANEE" Union, Air Drill.
" " Pump.
" " Boiler Couplings.
" " Circulating Boiler Couplings.
" " Eccentric.
" " Ells and Tees.
" " Extra Heavy.
" " Flange.
" " Hexagon.
" " Hose.
" " Hydraulic.
" " Male and Female.
" " Octagon.
" " Radiator Gate Valves.
" " " " Valves, Special Pattern.
" " Round.
" " Service Cocks.
" " Specialties.
" " Standard Gate Valves.
" " " Globe and Angle Valves.
" " Swing Check Valves.
Keys for Lock and Shield Valves.
" " Radiator Air Valves.
" " Street Washer.
Laterals, Standard and Extra Heavy.
" Flanged.
" Reducing.
" Straight.
Lock-Nut Tank Nipples.
Lock-Nuts, Brass, Cast Iron and Malleable.
" Casing.
" Faced.
Long Screw Couplings.
" " Followers.
" Screws.
" Sweep Fittings, Standard and Extra Heavy.
" " " Crosses.
" " " Ells.
" " " Flanged, Cast Iron.
" " " Tees.
" Turn Fittings, Flanged and Screwed.
" " Y Branches.
Machine Bolts.
Malleable Fittings, Plain and Beaded.
" " Standard and Extra Heavy.
" Acorns.
" Boiler Fittings.
" Bracket Ells.
" Bushings.

Malleable Caps.
" Chandelier Hooks and Loops.
" Circulating Boiler Fittings.
" Cock Wrenches.
" Couplings.
" " Faced.
" " Hexagon.
" " Long Screw.
" " Offset Reducing.
" Crosses.
" " R. H.
" " R. & L.
" Cross-Over Tees.
" Cross-Overs.
" " Back Outlet.
" Drive Caps.
" " Shoes.
" Drop Ells, Female.
" " " Male and Female.
" " Tees, Female.
" " " Male and Female.
" Elbows and Tees.
" " 45 Degree.
" " " " Street.
" Extension Pieces.
" Faced Bushings.
" Flange Unions.
" Followers, Faced.
" " Long Screw.
" 4-Way Tees.
" Hydrant Clamps.
" " Handles.
" Hydraulic Flange Unions.
" " Fittings.
" Lock Nuts.
" Long Drop Ells.
" Nipples, Hexagon, R. & L.
" Nipple Tees.
" Offset Reducing Couplings.
" Railing Fittings.
" Reducing Couplings.
" Reducers.
" Return Bends.
" " " Close Pattern.
" " " Open Pattern.
" Saddles.
" Service Clamps.
" " " Y Pattern.
" Side Outlet Ells and Tees.

Malleable Steam Pipe Saddles.
" Straps.
" Street Elbows.
" " Tees.
" " Washer Keys.
" 3-Way Ells.
" Union Ells and Tees.
" Unions.
" Wall Plates.
" Waste Nuts.
" Water Pipe Clamps.
" Wrenches, Cock.
" Y Branches, Parallel.
" Y's.
" " Double Branch.
" " 45 Degree.
" " 60 Degree.
Manifolds.
Marcy Check Tubular Well Valves.
" Plunger Tubular Well Valves.
Meter Cocks, Gas.
" " " with union and lock.
" " " " "KEWANEE" Union.
" " Lock.
" " " Gas Service.
Nipple Tees.
Nipples, Brass, Malleable and Wrought.
" " Soldering.
" Casing.
" Galvanized.
" Lock Nut.
" Long Screw.
" R. & L. Hexagon Center.
" Tank.
Offsets, Flanged, Cast Iron.
Plates, Cast Iron, Ceiling.
" " " Expansion.
" " " Floor.
" " " Hook.
" " " Ring.
" Malleable, Wall.
Plugs, Brass, Cast Iron and Malleable.
" Countersunk.
" Galvanized.
" Left Hand.
" Radiator, Ornamental.
" Solid.
" Tapped for Air Valves.

This information supplements that on pages 4, 7, 167 to 182

Points, Drive Well, Brass Jacket.
" Flush or Tubular Well.
" Open Center Banner.
" Scott Perfection, Drive Well.
" Single Screen.
" Washer.
Poppet Tubular Well Valves, All Brass.
Radiator Air Valves, Compression.
" " " and Keys.
" Bushings.
" Connections, Union Elbows, Brass.
" Gate Valves with "KEWANEE" Union.
" " " "KEWANEE" Union, Special Pattern.
" Valves.
" " Brass Disc.
" " Corner.
" " " "N. T. C." Jenkins Disc.
" " Hot Water.
" " Jenkins Disc, "N. T. C.", with Lock and Shield.
" " " " " " Union.
" " " " " without Union.
" " Lock and Shield.
" " Quick Opening.
" " Special Brass Disc with Union.
" " " " " without Union.
" " " Jenkins Disc, "N. T. C.", with Union.
" " " " " " without Union.
" " " " " " with "KEWANEE" Union.
" " with or without Union.
Radiators, Wrought Pipe and Wrought Tubing, Circular, Staggered Tube.
" Wrought Pipe and Wrought Tubing, Vertical Tube 1 Row Tubes.
" Wrought Pipe and Wrought Tubing, Vertical Tube, 2 Rows Tubes.
" Wrought Pipe and Wrought Tubing, Vertical Tube, 3 Rows Tubes.
" Wrought Pipe and Wrought Tubing, Vertical Tube, 4 Rows Tubes.
" Wrought Pipe and Wrought Tubing, Vertical Tube, 5 Rows Tubes.
" Wrought Pipe and Wrought Tubing, Vertical Tube, 6 Rows Tubes.
Railing Fittings, Brass and Malleable Iron.
Reducers, Brass.

This information supplements that on pages 4, 7, 167 to 182

Reducers, Cast Iron.
" Casing.
" Eccentric.
" Flanged.
" Galvanized.
" Malleable, Beaded and Plain.
" Offset, Eccentric.
" Standard and Extra Heavy.
" Taper, Flanged.
Reducing Fittings, Brass, Cast Iron and Malleable.
" " Bushings.
" Cast Iron Companion Flanges, Standard and Extra Heavy.
" " " Crosses, Flanged.
" " " Double Branch Elbows.
" " " " " Tees, Standard and Extra Heavy.
" " " " 90 Degree Y Branches, Tee Pattern.
" " " " Branch 90 Degree Y Branch.
" " " " Branch Tees, Standard and Extra Heavy.
" " " " 90 Degree Y Branches, Tee Pattern.
" " " " 90 Degree Long Turn Y Branches Tee Pattern.
" " " Elbows, Flanged, Standard and Extra Heavy.
" " " Elbows, Screwed, Standard and Extra Heavy.
" " " Flanges.
" " " Four-Way Tees, Flanged.
" " " Laterals, Flanged, Standard and Extra Heavy.
" " " Side Outlet Elbows, Flanged, Standard and Extra Heavy.
" " " Single Sweep Tees, Flanged, Standard and Extra Heavy.
" " " Taper Elbows, Flanged, Standard and Extra Heavy.
" " " Tees, Flanged and Screwed, Standard and Extra Heavy.
" " " Tees, Casing.
" " " Twin Elbows.
" " " Y Branches, Flanged, Standard and Extra Heavy.

This information supplements that on pages 4, 7, 167 to 182

Reducing Cast Iron Y Branches, Double 45 Degree.
" Crosses, Brass.
" " Casing.
" Elbows, Brass.
" " Casing.
" Malleable Couplings.
Regrinding Valves, "N. T. C.", Globe, Angle and Check, Brass.
Return Bends, Brass, Cast and Malleable Iron.
" " Back Outlet.
" " Beaded, Medium and Open.
" " Car Heater.
" " Casing.
" " Close, Plain.
" " Galvanized.
" " Open and Flat Back.
" " Pitched.
" " Screwed, Standard and Extra Heavy.
" " Wide Pattern.
Rod Couplings, Drill.
" " Malleable.
" " Wood.
" Sockets, Pump.
Roof Connections.
Running Traps.
Saddle Flanges, Cast Iron.
Saddles, Steam Pipe, Malleable.
Safety Valves, Brass, Brass Disc.
" " " Jenkins Disc, "N. T. C.", Angle and Cross.
" " Iron Body.
" " Low Pressure, Ball Weighted.
Screws, Long.
Sheet Brass, Perforated for Single Screen Drive Well Points.
Shoes, Drive, Malleable.
Sockets, Pump Rod.
Sprinkler Fittings.
" Valves.
Stands, Laundry Coil.
Steam Fittings, Brass, Wrought Pipe Size.
Strainers, Artesian Well.
" Large Irrigation.
" Suction Pipe.
Stuffing Boxes, Brass.
Swing Check Valves, Brass.
" " " Iron Body, Horizontal and Vertical.
Swing Check Valves, "KEWANEE" Union.
Syphons, Steam Gauge.

...is information supplements that on pages 4, 7, 167 to 188

Tees, Brass, Rough and Finished.
" Cast Iron, Branch.
" " " Car Heater.
" " " Casing.
" " " Circulation.
" " " Double Sweep, Flanged.
" " " Eccentric.
" " " Flanged, Side Outlet.
" " " 4-Way Flanged.
" " " Long Sweep, Screwed.
" " " " Turn, Screwed.
" " " Screwed and Flanged.
" " " Single Sweep, Flanged.
" " " Standard and Extra Heavy.
" Malleable, Beaded and Plain, Screwed.
" " Drop.
" " " Male and Female.
" " Eccentric.
" " 4-Way.
" " Hydraulic.
" " "KEWANEE" Union.
" " Long Drop.
" " Railing.
" " Service.
" " " with Male Branch.
" " Side Outlet.
" " " " Railing.
" " Union.
Traps, Running.
" Steam.
Tuyere Cocks, 3-Way, Brass, Heavy.
Union Bends.
" Boiler Couplings, "KEWANEE."
" Angle Valves, "KEWANEE."
" Elbows, "KEWANEE."
" " Malleable.
" " Radiator.
" Gate Valves, "KEWANEE."
" Globe Valves, "KEWANEE."
" Service Cocks, "KEWANEE."
" Swing Check Valves, "KEWANEE."
" Tees, "KEWANEE."
" " Malleable.
Unions, Brass, Finished.
" " Flange, Hydraulic.
" " " Rough.

This information supplements that on pages 4, 7, 161 to 182

Unions, Brass, Octagon.
" Cast Iron, Flange.
" " " " "NATIONAL."
" " " " Oil Country.
" " " " With Lip.
" Malleable Flange.
" " " Hydraulic.
" " " "KEWANEE."
" " Two-thirds.
" "KEWANEE" Air Drill.
" " " Pump.
" " Eccentric.
" " Extra Heavy.
" " Flange.
" " Hexagon.
" " Hose.
" " Hydraulic.
" " Male and Female.
" " Octagon.
" " Round End.

Valves, Brass.
" " Acid.
" " Air.
" " Blast Furnace.
" " Check.
" " " Adjustable.
" " " Angle.
" " " Horizontal.
" " " with Drip Cock.
" " " Jenkins Disc, "N. T. C."
" " " "N. T. C." Regrinding.
" " " Swing.
" " " " "KEWANEE" Union.
" " " Vertical.
" " Coke Oven.
" " Cross.
" " " Handle.
" " " " with Slip Joint.
" " Gate.
" " Globe.
" " Hose.
" " Jenkins Disc, "N. T. C."
" " Lock and Shield, Natural Gas.
" " "N. T. C." Regrinding.
" " Needle Point.
" " No. 2 Competition.

Valves, Brass, Radiator.
" " " Air.
" " " Corner, Offset.
" " " Gate, with "KEWANEE" Union.
" " " Hot Water.
" " " Special, with "KEWANEE" Union.
" " " " "N. T. C." J. D., with Lock and Shield.
" " " " " " with Union.
" " " " " without Union.
" " Safety.
" " " Low Pressure.
" " Y.
" " " Special Pattern.
" " " with "N. T. C." Jenkins Disc.
" Iron Body, Angle, Check, Gate and Globe.
" " " " Flanged with Yoke.
" " " " Screwed with Yoke.
" " " Check, Horizontal and Vertical.
" " " " Swing.
" " " " " with "N.T.C." Jenkins Disc.
" " " Cross, Screwed with Yoke.
" " " "Eurema" Y.
" " " Flanged and Screwed, with Yoke.
" " " Foot.
" " " Gate, Blast Furnace.
" " " " Compound Screw, O. S. & Y.
" " " " Converse Joint, N. R. S.
" " " " Double Disc, N. R. S., Flanged or Hub End.
" " " " Double Disc, N. R. S., Screwed.
" " " " " " N. R. S.; O. S. & Y.; Screwed or Flanged.
" " " " Electrically Operated.
" " " " for Wood Pipe.
" " " " Gear Operated.
" " " " Half-Rising Stem.
" " " " Hub End, N. R. S.
" " " " " and Spigot, N. R. S.
" " " " Hydraulic.
" " " " Matheson Joint.
" " " " N. R. S. Double Disc.
" " " " " Spigot End.
" " " " " Wedge Disc.
" " " " " with By-pass.
" " " " O. S. & Y. Double Disc.

'ormation supplements that on pages 4, 7, 181 to 182

Valves, Iron Body, Gate, O. S. & Y. Spigot End.
" " " " " Wedge.
" " " " " with By-pass.
" " " " Quick Opening.
" " " " Screwed.
" " " " Swing Check.
" " " " Underwriters' Indicator, Double Disc.
" " " " Underwriters' Indicator, O. S. & Y.
" " " " " " Wedge Disc.
" " " " with Spur or Bevel Gear.
" " " " " Union, Blast Furnace.
" " " " " Yoke.
" " " Globe and Angle.
" " " " " " Brass Mounted, Screwed, and Flanged.
" " " " " " Brass Mounted, "N.T.C." Jenkins Disc.
" " " " " " Brass Mounted, Plain.
" " " " " " Brass Mounted, with Yoke.
" " " " " " Screwed and Flanged.
" " " " " " with "N. T. C." Jenkins Disc.
" Radiator Air.
" " Corner, Offset.
" " Gate, with "KEWANEE" Union.
" " Hot Water.
" " Special with "KEWANEE" Union.
" " " "N.T.C." J. D. with Lock and Shield.
" " " " " " Union.
" " " " " without Union.
" " " " " with or without Union.
" " with or without Union.
" Safety, Weight and Lever, Brass.
" " " " " Iron Body.
" Sprinkler.
Wall Plates, Malleable.
Washer Keys, Malleable.
" Points, Wrought.
Waste Nuts, Malleable.
Water Columns, Cast Iron.
" Fittings, Long Sweep, Cast Iron.
" Gate Valves, Iron Body.
" Pipe Clamps, Malleable.
" " Saddles, Malleable.

This information supplements that on pages 4, 7, 167 to 182

Well Cylinders, Eureka Tubular.
" " Tubular, Brass Lined.
" " Wrought, Tubular.
" Points, Brass Jacket.
" " Drive and Well Supplies.
" " Extension or Open End.
" " Flush or Tubular.
" " Large Size.
" " " " Railroad.
" " " " Water Works.
" " Open Center Banner.
" " Scott Perfection.
" " Single Screen.
" " Washer.
" Valves, Tubular.
" " All Brass Spool Poppet.
Wheels and Handles for Brass Valves.
" for Iron Body Valves.
Wire Cloth, Brass, New and Renovated.
Wrenches for Steam and Gas Cocks, Malleable.
" " Lock Shield Air Cocks.
Wrought Fittings.
" Couplings.
" " Car Heater.
" " Casing.
" " Drill Rod.
" " Long Screw and Followers.
" " Sleeve Tubing.
" Nipples.
" " Casing.
" Tube Radiators.
" Tubular Well Cylinders, Barrel Only.
" " " " Complete.
Y Bends, Brass, Cast and Malleable Iron.
" " Casing.
" Branches, Cast Iron, Flanged, Standard and Extra Heavy.
" " " " Reducing.
" " " " Screwed.
" " Malleable, Double, Screwed.
" " " Parallel Banded.
" Valves, Brass, "Eurema."
" " " "N. T. C." Jenkins Disc.
" " " Special Pattern.
" " Iron Body.
" " " " "Eurema."
Y's, Casing.

This information supplements that on pages 4, 7, 167 to 182

USES OF "NATIONAL" PIPE

To many people pipe is just "pipe"—a product used for conveying gases and liquids from one point to another. While it is true that a large proportion of the pipe in use at the present time is used for these purposes, still, the number of uses for pipe in the mechanical field is exceedingly large, and is rapidly increasing.

The list of a number of uses of "NATIONAL" Pipe which follows is not complete, but is fairly representative of the varied uses of "NATIONAL" Pipe.

Accessories for Air and Electric Drills.
Acid Piping.
Agricultural Implements
Air Brake Pipes, Compressors, Inter Coolers.
" Conductors.
" Distributing Apparatus.
" Drills.
" Drums.
" Lines.
" Pumps.
" Shafts.
Ammonia Coils.
" Cylinders, Anhydrous.
" Lines.
Anhydrous Ammonia Cylinders.
Animal Cages.
Apparatus, Air Distributing.
" Dry Kiln.
" Gymnasium.
" Ice Making.
" Play Grounds.
" Steam Gauge Testing.
Arc Light Supports.
Arch Pipes.
Automobile Exhaust Pipes.
" Gear Shifts.
" Manufacture of.
Awning Brackets.
" Frames.
" Pipe, Manufacture of.

Axles.
" for Newspaper Rolls.

Baby Carriages.
Baker-Heater Pipes.
Balcony Railings.
Barrels, Blasting.
Beams, Brake.
Bed Steads.
" " Frames for.
" " Manufacture of.
Beer Coolers.
" Pipes.
Beet Toppers.
Bell Cord Protecting Pipe.
Bends, Steam.
Bicycles, Manufacture of.
Blast Furnace Bustle Pipes.
Blasting Barrels.
Blower Pipe.
Blowing Engines.
Boiler Tubes.
Bolts, Foundation.
Box Coils.
Braces, for Structural Work.
Bracket, Awnings.
" Coils.
Brake Beams.
Bridge Pipe, Locomotive.
Building, Columns.
" Construction.
Bushings.

This information supplements that on page 7

Cages, Animal.
Candelabra.
Carriages, Baby.
Cars, Elevator
Casing.
" Dog Guard.
" for Elevator Plungers.
Catchers, Cow.
Cement Conveyors.
Chain Supports for Subway Cars.
Chairs, Invalid.
Chandeliers.
" Electric.
" Gas.
Chemical Conveyors.
Chutes for Scrap Metal.
Clay Transmission Lines.
Clothes Reels.
Coils.
" Ammonia.
" Box.
" Bracket.
" Condenser.
" Conductor.
" Heater.
" Heating, for Mine Service.
Columns for Buildings.
" Pump.
Condenser Coils.
" Tubes for Sugar Refineries.
" " " Various Purposes.
Conductor, Air.
Conduit.
" Electrical.
" Insulation.
Connecting Rods.
Construction, Building.
Conveyors, Cement.
" Chemical.
Coolers, Ice.
Cooling Systems, Gas Engine.
Cores.
Cots.
Cow Catchers.

Cups, Thermometer.
Cyanide Process for Refining Metals.
Cylinders.
" for Anhydrous Ammonia.
" " Elevator Plungers.
" Oxygen.
Cylinders, Loom.
" Oil Well.
" " Pneumatic Tools.

Dead Rollers.
Die Stock Handles.
Diggers, Post Hole.
" Potato.
Discharging Pipe for Condensers on Steam Lines.
Distance Pieces in Mine Railwork.
Dollies, Timber.
Drain Pipes.
Drainage Lines.
Dredge Discharge Lines.
Drill Pipe.
" Rods.
Drills, Air.
Drilled Wells.
Drinking Water Systems.
Drive Pipe.
" Well Points.
Driven Wells.
Dry Kiln Apparatus.
Dry Pipes.

Electric Conduit.
" Dynamo Supports.
" Heaters.
" Light Supports.
" Line Poles.
" Motor Frames.
" Sign Supports.
" Signal Supports.
" Truck Frames.
" and Air Drill Accessories.
Elevator Cars and Grill Work.

his information supplements that on page 7

Elevator Casing for Plungers.
" Grain Spouts.
" Plungers.
Engine Supports in Automobiles.
Exhaust Pipes.
Expansion Pipes.

Farming Implements.
Feed Pipe, Intercooling.
" Line on Gas Stoves.
Fence Posts.
Fences, Ornamental.
" Tennis Court.
Fenders, Car.
Fire Escape Work.
Fishing Rods.
Flag Poles.
Flush Tubing.
Foot Rails.
Foundation Bolts.
Frames, Agricultural.
" Awning.
" Bed Stead.
" Electric Signs.
" Trucks.
" Gymnasium.
" Machinery.
" Mattress.
" Play Grounds.
" Reading Stand.
" Wheelbarrow.
" Work Bench.

Gas Chandeliers.
" Conductor.
" Engine Cooling Systems.
" Fixtures.
" Lines.
" Stoves.
" " Feed Line.
" " Railing.
Gasoline Lines.
Gates
" Ornamental.
Grain Spouts, in Elevators.
Grape Vine Trellis.
Grill and Elevator Work.
Grip Pipe.
Guard Rails.
Guards, Window.
Gymnasium Apparatus.

Hammers, Steam.
Hand Rails.
Handles.
" Die Stock.
" Lever.
" Shovel.
Hawser.
" Pipe for Boats.
Headers.
Heater Coils.
Heaters, Electric
" Instantaneous.
Heating Systems.
" Coils for Mine Service.
Heavy Railing.
Hitching Posts.
Hollow Shafts.
Hospital Furniture.
Hot Air Furnaces.
Hydraulic Discharge Pipe.
" Ram Casing.
" Transmission Lines.
Hydro Electric Power Transmission Lines.

Ice Making Apparatus
" Coolers.
Implements, Farming.
Instantaneous Heaters.
Inter Coolers, Air Compressors.
Invalid Chairs.
Irrigation Systems.

Jacks, Manufacture of.
Jail Windows and Doors.

Kiln Dry, Apparatus.

This information supplements that on page 7

Ladder Rungs.
Ladders.
Lamp Brackets.
" Posts.
Lathes, Manufacture of.
Lever Rods for Jump Saws.
" Handles.
Line Pipe.
Lines, Air.
" Ammonia.
" Clay Transmission.
" Discharge.
" Drainage.
" Dredge.
" Hydraulic Transmission
Lines, Phosphate Rock Transmission.
" Sewerage.
" Steam.
" Water.
" " for Sprinkling in Dusty Mines.
Live Rollers in Lumber Mills.
Locomotive Bridge Pipes.
" Sand Pipes.
Loom Cylinders.
Lunch Counter Stools.

Machinery Frames.
Mandrels.
Manufacture of Automobiles.
" " Bed Steads.
" " Bicycles.
" " Motorcycles.
Masts.
" Warship.
Mattress Frames.
Mines, Pneumatic Signals for.
Motorboat Exhaust Pipes.
Motorcycles, Manufacture of.

Newspaper Axle Rolls.
Novelties.
Nipples.

Office Railings.
Oil Lines.
" Well Casing.
" " Cylinders.
" " Drive Pipe.
" " Rotary Drive Pipe.
" " Tubing.
Ornamental Fixtures.
" Work for Light Poles.

Paint Lines.
Paper Cores.
Partitions.
Phosphate Rock Transmission Lines.
Piano Movers' Rollers.
Piling for Piers and Docks.
Pillars.
Pipe.
" Acid.
" Air Brake.
" Arch.
" Baker-Heater.
" Blast Furnace Bustle.
" Blower.
" Drain.
" Drill.
" Dry.
" Exhaust.
" Expansion.
" Locomotive Bridge.
" Motorboat Exhaust.
" Protection for Bell Cords.
" Racks.
" Stands.
Piston Rods.
" " of Shot Gun on Lumber Carriages.
Play Ground Apparatus.
Plumbing Systems.
Plungers.
" Casing.
" Elevator.
Pneumatic Signal System for Mines.
" Tool Cylinders.
Points, Drive Well.

This information supplements that on page 7

Poles.
" Electric Lighting.
" Flag.
" Power Transmission.
" Railway Signal.
" Telegraph.
" Telephone.
" Traction.
" Transmission.
" Wireless Telegraph.
Post Hole Diggers.
Posts, Fence.
" Sign.
Potato Diggers.
Power Plants.
Printing Press Rollers.
Protecting Pipe for Bell Cords.
" Tubes for Pyrometers.
Pump Columns.
" Handles.
Pump Plungers.
" Set.
Pumps.
" Air.
Pyrometer Protecting Tubes.

Racks, Display for Clothing, etc.
Radiators.
Railings.
Railroad Tell Tables.
Railings for Balconies.
" Office.
Rails, Foot.
" Hand.
" on Gas Stoves.
Railway Signal Poles.
" " Rods.
Ram Casing, Hydraulic.
Reels, Clothes.
Refrigerating Systems.
Refineries.
Refining; Cyanide Process.
Retorts.
Rocker Frames for Rocker Lumber Saws.
Rods.
" Connecting.
" Drill.
" Fishing.
" Lever.
" Railway Signal.
" Sucker.
Rollers, Dead.
" Heavy-weight.
" Moving.
" Piano Movers'.
Rolls, Newspaper Axle.
Rotary Pipe.
Rotary Drive Pipe.
Rungs.
" Ladder.
Runners for Sleighs.

Safe Ends.
Sand Pipes for Locomotives.
Scrap Metal Chutes.
Sewerage Lines.
Shafting.
Shafts.
" Hollow.
" Pulley.
Shovel Handles.
Sign Posts.
Signal Apparatus.
" Interlocking.
" Pneumatic, for Mines.
" Poles.
" Rods.
" Towers.
Signals, Railroad.
Sign, Electric, Supports for.
" Posts.
Size Rings (for driving down wood piling).
Sleeves.
Socket Wrenches.
Speaking Tubes.
Spokes for Wheels.
Spouts, Grain, in Elevators.
Sprinkler Systems.
" for Dusty Mines

Stanchions.
Stand Pipes.
Steam Bends.
" Conductors.
" Feed Valves Connecting Rod for Lumber Carriage.
" Gauge Testing Apparatus.
" Hammers.
" Lines.
Stools for Lunch Counters.
Stoves, Manufacture of.
Strainers.
Structural Work Braces.
Sucker Rods.
Superheater Calorimeter Parts.
Supporting Rods for Water Meter.
Supports for Chimneys.
" " Dynamos.
" " Electric Signs.
" " Tables.
Systems,
" Drinking Water.
" Fire Protection.
" Gas Engine Cooling.
" Heating.
" Irrigation.
" Plumbing.
" Pneumatic Signal for Mines.
" Refrigerating.
" Sewerage.
" Signal.
" Sprinkler.
" Vacuum.
" Water.

Table Supports.
Tanks.
Telegraph Poles.
Telephone Poles.
Turn Tables, Railroad.
Tennis Court Fences.
Thermometer Cups.
Timber Dollies.
Tools, Pneumatic Cylinders for.
Toppers, Beet.
Towers, Signal.
" Transmission Line.
" Windmill.
Transmission Lines.
" " Clay.
" " Electric.
" " Hydraulic.
" " Power.
" " Towers.
Trolley Poles.
Trucks, Frames for Electric.
Trunks, Manufacture of.
Tubes,
" Boiler.
" Condenser, for Sugar Refineries.
" Pyrometer Protecting.
" Speaking.
Tubing, Flush.
Tubular Poles.
Turnstiles.
Tuyere Pipes.

Vacuum Systems.

Warship Masts.
Water Conductors.
Water Drinking Systems.
" Lines.
" Meter Supporting Rods.
Well Points.
" " Drive.
" Casing.
Wells, Drilled.
" Driven.
Wheel Barrow Frames.
" " Handles.
" Spokes.
Windmill Towers.
Window Guards.
Wireless Telegraph Apparatus.
" " Poles.
" " Towers.
Wrenches, Socket.

is information supplements that on page 7

SOME USES OF "SHELBY" SEAMLESS STEEL TUBING

Adjustable Lamp Supports.
Agricultural Implements.
Air Compressors.
" Drums.
" Hammer Barrels.
Arbors for Revolving Paper Slitters.
Armature Shaft Sleeves.
Automatic Battens for Ribbon Loom.
Automobile Parts.
" Axles.
" Coils.
" Engines, Manufacture of.
Axles of All Kinds.
Almond Drill Chuck.
Airships.
Animal Cages.
Artificial Limbs.
Automatic Piano Players.
" Ice Cream Freezers.

Baby Carriages, Manufacture of.
Balcony Railing.
Ball Bearings.
" Bearing Cages.
" " Sleeves.
" Retainers.
Barrel Drills.
Bedsteads, Manufacture of.
Beer Cooling Tubes.
Bicycles, Manufacture of.
Bicycle Hangers.
" Pumps.
Blow Pipes.
Boring Bars.
" Bar Spindles.
Braces.
Brush Machinery, Manufacture of.
Burial Devices, Manufacture of.
Burner Pipes.
Burners, Automobiles.
Bushings.
Brick Cutting Drills for Electric and Telephone Work.
Bushings for Carrying Idle Rolls.
Bends on Steam Pipe.
Boiler Tubes.
Butter Cutters.
Bulb, Electric, Manipulators.
Button Cutters.
Bowling Pin Setters.
Bologna Sausage Stuffing Machines.
Bicycle Repair Work.
" Hubs.
Book Stacks.
Bottle Washing Machine, Manufacture of.
Bells.

Carbonic Acid Gas Cylinders.
Card Grinders.
Carriage Trimmings.
Cash Cups for Cash Carriers.
" Registers, Manufacture of.
Casting Machine Bushings.
Cloth Singeing Machinery, Manufacture of.
Coaster Brakes.
Coils.
Collars.
Condensers, Manfacture of.
Conducting Tubes.
Construction of Concrete Molds.
Core Barrels.
" Machine Dies.
Cream Separator Bowls.
Curling Irons.
Cycle Motors. Manufacture of.

Chimes.
Cigar Cutters.
Cutting Punches.
Church Truck.
Car Wheels, Guide Frames.
Clothes Driers.
Cigarette Machine.
Carbureters.
Conduits, Manufacture of.
Cars, Manufacture of.
Coffee Mills, Electric.
Couches, Manufacture of.
Crucible Melting Pots.
Candy Molds, Chocolate.
Cylinders, Air Hoist.
" Shipping Container.
" Anhydrous Ammonia.

Dental Chairs, Manufacture of.
" Engines, Manufacture of.
Diamond Drill Rods.
Die Stock Handles.
Draw Bars for Bench Lathes.
Drills, Manufacture of.
" for Air Hammer Rock Drills.
Drill Rods.
" Shanks.
Drive Point Hose Nozzles.
Dyeing Machines, Manufacture of.
Draughting Tools.
Drill Feed, Manufacture of.
Dash Pots.

Eccentric Rods.
Electric Soldering Irons.
Elevators, Manufacture of.
Elevator Cars, Manufacture of.
" Enclosures, Manufacture of.
" Plungers.
Emery Wheel Dressers.
Engine Lathes, Manufacture of.
Evaporators, Manufacture of.
Exhaust on Gasoline Motors.
" Pipes.
Embalming Couches, Manufacture of.
Expansion Pulleys, Manufacture of.
" Pulley Rings.
Electric Fans.
Embalming Needles.
Electric Lamp Machinery, Manufacture of.

Feed Bars for Mining Machines.
" Nuts.
" Water Heaters, Manufacture of.
Fire Engines, Manufacture of.
Fleece Rollers for Knitting Mills.
Front and Rear Axle Housing.
Fishing Rods, Telescopic.
Flag Staffs and Masts.
Fountain Pens.
Fiber Tubes.
Floor Sanding and Polishing Machines.
Filing Devices.
Filters, Manufacture of.
Forms, Rubber Hose.
Forks, Manure and Hay.
Forgings, Substitute for.

Gas Arc Lamps.
" and Electric Fixtures.
" Burner Thimbles.
" Coils.
" Making Machinery, Condensers on.
" Pipes.
Gauge Bodies.
Gear Blank Sleeves.
" Blanks.
Generator Sleeves.

This information supplements that on page 14

Gin Saw Filing Machine Rods.
Go-Carts, Manufacture of.
Governor Spring Tubes.
Gun Barrels.
" Carriages.
Gas Engine Cylinders
" Main Stoppers.
Grinder, Sample, Hand.
Governors, Manufacture of.
Gun Barrel Drills.
Gravity Carriers.
Grilles, Bank Vaults.
Gas Producer, Manufacture of.
Gongs.
Golf Clubs.

Hames, Fire Department.
Hand Extractors.
Handles.
Handle Bars.
Harvesters, Manufacture of.
Hay Presses, Manufacture of.
Heaters, Manufacture of.
Heater Coils.
Hollow Axles.
" Drills.
" Piston Rods.
" Shafts.
Horse Clipping Machines.
" Powers, Manufacture of.
Hose Nozzles.
" Poles.
Hydraulic Dies.
" Gauge Tubes.
" Jack Tubes.
" Swivels.
Hypodermic Needles.
Hand Railings.
Hubs for Hospital Carriages.
Hammer Drills, Manufacture of.

Invalid Chairs, Manufacture of.

Jacks, Manufacture of.
Jack Spools.

Kerosene Burner, Vaporizer Tubes.
Knife Handles.
Knurled Nuts for Pipe Wrenches.
Knitting Machines, Manufacture of.
" Machine Cylinders.

Lamps, Manufacture of.
Lamp Tube Supports.
Lap Pins for Spinning Mills.
Lathes, Manufacture of.
Lathe Plungers.
" Spindles.
" Torch Tops.
Laundry Machinery, Manufacture of.
Lever Shafts.
Light Inspection Cars.
Loom Shuttle Bars.
Loose Leaf Devices, Manufacture of.
Ladder Rungs, Fire.
Lawn Mowers.

Machine Tools.
Magazine Nipples.
" Tools, Manufacture of.
Mandrels.
Models.
Motorcycles, Manufacture of.
Motor Cylinders.
" Shafts on Vehicle Motors.
Music Racks.
Metal Furniture.
Mortars, Fireworks.
Moving Picture Apparatus.
Merry-go-rounds.
Moving Picture Machine Stands.
Monotypes.

This information supplements that on page 14

Marine Boilers.
Mill Machinery, Lath and Shingle.

Napping Machinery Rolls.
Novelties, Manufacture of.

Office Railing.
Oil Tank Spouting.
" Tubes for Engine Lathes.
" " " Machinery and Pulleys.
" Well Boilers.
Ornamental Iron Work.
Operating Tables, Manufacture of.

Paper Hangers' Straight Edges.
" Spool Holders.
Pipe Wrenches.
Pipes, Ammonia.
Piston Rods.
Platen Cores.
Plunger Elevators, Manufacture of.
Plungers for Lathes.
" " Machines.
Pneumatic Hoist Cylinders.
" Tubes.
Polishing Rolls.
Post Hole Augers.
Posts for Wire Machine.
Power Drill Parts.
Printers' Rolls.
Printing Presses, Manufacture of.
" Press Rolls.
Prison Cell Door Hangers.
Pruning Knife Handles.
Pump Plungers.
Pumping Machinery, Manufacture of.
Paper Cutters.
Phonographs, Manufacture of.
Piston Rod on Steam Feed Cylinders.

Pyrometers.
Pole Props.
Pantagraph Trolleys.
Picker Rolls.
Peanut Picking Machines.
Plug Cutter.
Pump Cylinders.
Perforating Machines, Manufacture of.

Racks, Cake.
Railroad Cycle Velocipedes, Manufacture of.
Ratchet Braces.
" Brace Collars.
" Handles.
Re-enforcement in Baseball Bats.
Retorts.
Rifling Rods.
Road Rollers, Manufacture of.
Rollers for Gravity Carriers.
Roller Bearings.
" Bearing Axles.
" " Axle Bushings.
" " Casing.
" " Hub Bushings.
" " Skein and Bore Covers.
" Shelving.
Racing Boat Outriggers.
Rollers to Carry Vanner Belts.
Rods on Steam Cylinders.
Rails, Caissons and Limbers.
Roller Skates.
Refrigerating Machinery.
Rubber Tubing, Manufacture of.
Rifle Magazine.
" Shanks.
Reach Rods.
Reeling Machines.
Rake, Hay.
Racks, Display.
Refrigerators, Manufacture of.

This information supplements that on page 14

Sand Pumps.
Saw Mills, Manufacture of.
Scientific and Engineering Instruments, Manufacture of.
Screw Drivers, Manufacture of.
" Machinery Spindles.
" " Manufacture of.
Seal Mechanism Covers.
Self Hardening Steel Tool Holders.
Shaft Collars.
" Covers.
Shingle Sawing Machinery, Manufacture of.
Shrapnel Cases.
Shuttle Bars for Looms.
Signal Apparatus, Manufacture of.
Silk Warping Machinery, Manufacture of.
Sleeves and Nuts for Bit, Lengthening Attachment.
Sockets.
Speed Wagons, Manufacture of.
Spinning Spindle Caps.
Steam Feed Piston Rods.
" Rollers, Manufacture of.
Steering Handles.
" and Operating Lever Shafts.
Stop Motions.
Store Fixtures.
Stoves, Manufacture of.
Street Rollers, Manufacture of.
Sulkies, Manufacture of.
Superheaters, Manufacture of.
Syringes, Manufacture of.
Sand Blast Hose Nozzles.
Socket Wrenches.
Spokes for Wagon Wheels.
Spindles for Steam Governors.
Steering Rods.
Signals, Release.
Soap Molds.
Sliding Poles, Firehouse.
Sewing Machines.
Steam Shovels.
Shaft and Pole Shifters.
Safe Locks.
Shafts for Agitators.

Tanks, Manufacture of.
Telescopes.
Telescope Dust Tubes.
Threaded Bushings or Steering and Operating Lever Shafts.
Tools, Diamond Drilling.
Towel Rack Rods.
Traction Engines, Manufacture of.
Tricycles, Manufacture of.
Trocars.
Trolley Poles.
Tubular Turnbuckles.
Typewriters, Manufacture of.
Toy Pistol Barrels.
Trapeze Apparatus.
Thimble Roller Chain.
Torpedo Construction.
Telephone Instruments.
Tempering Pots.

Umbrella Rods.

Valves, Manufacture of.
Vaporizing Coil.
Vise Screw Collars.
Vacuum Cleaner Nozzles.
" House Cleaning Machinery.
Valve Stems.

Wagon and Gas Connections.
Weaving Machine Spindles.
Walking Canes.
Wall Paper Rolls.
Wireless Telegraph Instruments.
Washing Machines.
Working Barrels, Manufacture of.
Warp Beams.
Water Gun.
Wagon Wheel Rims.

This information supplements that on page 14

THREADING

No additional information on the subject of Pipe Threading and Pipe Threading Dies is incorporated in this appendix.

A series of "NATIONAL" Bulletins containing technical data on such subjects as Threading, Corrosion, Processes of Manufacture, etc., have already been published by National Tube Company. These "NATIONAL" Bulletins are revised and enlarged whenever supplementary information is obtained, and each new edition is thus made up-to-date in technical data.

"NATIONAL" Bulletin No. 6, which covers the subject of Threading, will be sent to anyone upon request to the General Offices at Pittsburgh, or to any of the District Offices, list of which appears on page 5.

This information supplements that on pages 10, 11

CORROSION OF IRON AND STEEL
GENERAL BIBLIOGRAPHY

The following is a selection of the more important articles on the Corrosion of Iron and Steel, taken from the very valuable and complete Bibliography of Metal Corrosion and Protection published by the Carnegie Library of Pittsburgh.

The following abbreviations have been used:

Diag.	diagrams.	p	page.
Dr.	drawings.	pl.	plate.
Ill.	illustrations.	v.	volume.
n. d.	no date.	w.	words.
n. s.	new series.		

RELATIVE CORROSIONS

Fraser, Alexander G.

Relative rates of corrosion of acid and basic steel. 16 p. Folding pl. 1907. (In Journal of the West of Scotland Iron and Steel Institute, v. 14, p. 82.)

Discussion, p. 112. 20 p.

The same, condensed. 1,600 w. (In Iron Age, v. 79, p. 1196.)

Tests in air, river water, salt water, and sulphuric acid.

Howe, Henry M.

Relative corrosion of wrought-iron and steel. 5,600 w. 1895. (In Mineral Industry, v. 4, p. 429.)

The same, condensed. 1,600 w. (In Journal of the Iron and Steel Institute, v. 50, p. 427.)

Gives results both from laboratory experiments and from actual industrial use.

Relative corrosion of wrought-iron, soft steel, and nickel steel. 1,500 w. Dr. 1900. (In Engineering and Mining Journal, v. 70, p. 188.)

Relative corrosion of wrought-iron and steel. 1,800 w. Dr. 1906. (In Proceedings of the American Society for Testing Materials, v. 6, p. 155.)

Discussion, 7,000 w.

The same, condensed. 1,300 w. (In American Machinist, v. 29, p. 49.)

The same, condensed. (In Engineering Magazine, v. 31, p. 750.)

The same, condensed. (In Industrial World, v. 40, p. 228.)

The same, condensed. (In Iron Age, v. 77, p. 2047.)

Rapid corrosion of steel in many instances may be due to the inferior quality of the steel.

Gruner.

Recherches sur l'oxydabilité relative des fontes, des aciers et des fers doux. 1,000 w. 1883. (In Comptes rendus des Séances de l'Académie des Sciences, v. 96, p. 195.)

This information supplements that on pages 12, 13, 106, 275-277

Kosmann, B.

Ueber die corrosion von fluss- und schweisseisen und über den zerfall von legirungen. 2,100 w. 1893. (In Stahl und Eisen, v. 13, pl. 1, p. 149.)

The same, condensed. (In Journal of the Iron and Steel Institute, v. 43, p. 399.)

Difference in resistance to corrosion of ingot and weld is held to be due entirely to difference in their chemical composition.

Parker, William.

On the relative corrosion of iron and steel. 11,200 w. Dr. 1881. (In Journal of the Iron and Steel Institute, v. 18, p. 39.)

Effects of exposure in air, in sea-water, in marine boilers, etc.

Pillips, David.

On the comparative endurance of iron and mild steel when exposed to corrosive influences. 25 p. Dr. 1881. (In Minutes of Proceedings of the Institution of Civil Engineers, v. 65, p. 73.)

Discussion, 40 p.

Considers admiralty tests and tests by the author indicating greater resistance to corrosion of iron.

Rudeloff, M.

Bericht über vergleichende untersuchungen von schweisseisen und flusseisen auf widerstand gegen rosten. 125 p. Ill. 1902. (In Mittheilungen aus den Königlichen Technischen Versuchsantalten, v. 20, p. 83.)

The same, condensed. 4,000 w. (In Stahl und Eisen, v. 23, p. 384.)

The same, abstract. 1,500 w. (In Journal of the Iron and Steel Institute, v. 63, p. 713.)

Extensive experiments on the relative resistance to corrosion of wrought-iron and steel, considering the effect of different conditions and coatings and giving the relative corrosive action of various agencies.

Speller, Frank N.

Puddled iron versus soft steel. 2,200 w. Ill. 1905. (In Iron Age, v. 75, p. 1666. 1881.)

Claims equal resistance of iron and steel to corrosion, in reply to statements of Roe.

Corrosion of iron and steel. 900 w. 1907. (In Proceedings of the Engineers' Society of Western Pennsylvania, v. 22, p. 472.)

The same. (In Iron Age, v. 79, p. 478.)

Discussion, 1,800 w.

Gives results of tests showing steel to be superior to wrought-iron.

This information supplements that on pages 12, 13, 106, 275-277

CORROSION IN SEA-WATER

Andrews, Thomas.

On galvanic action between wrought-iron, cast metals, and various steels during long exposure in sea-water. 5,000 w. Ill. 1884. (In Minutes of Proceedings of the Institution of Civil Engineers, v. 77, p. 323.)

Corrosion of metals during long exposure in sea-water. 7,500 w. Ill. 1885. (In Minutes of Proceedings of the Institution of Civil Engineers, v. 82, p. 281.)

Diegel, H.

Einiges über die korrosion der metalle im seewasser. 95 p. Folding pl. 1903. (In Verhandlungen des Vereins zur Beförderung des Gewerbfleisses, v. 82, p. 91.)

The same, condensed. 4,500 w. (In Zeitschrift des Vereines Deutscher Ingenieure, v. 47, p. 1122.)

The same, abstract. 400 w. (In Journal of the Iron and Steel Institute, v. 65, p. 677.)

Extensive experiments lead author to claim that impure metals do not corrode in salt water faster than pure metals. Foreign elements introduced were phosphorus and nickel.

Farquharson, J.

Corrosive effects of steel on iron in salt water. 4,800 w. 1882. (In Transactions of the Institution of Naval Architects, v. 23, p. 143.)

Experiments indicating that contact of iron and steel should be avoided.

Discussion.

Johnstone, George.

Notes on the serious deterioration of steel vessels from the effects of corrosion. 7 p. 1901. (In Transactions of the Institution of Engineers and Shipbuilders in Scotland, v. 45, p. 71.)

Discussion, 28 p.

Especially on corrosion of internal parts of vessels and on vessels in the tropics.

Lidy.

Note sur l'altération des métaux par l'eau de mer. 2,200 w. Ill. 1897. (In Annales des ponts et chaussées, mémoires, ser. 7, v. 14, 3e trimestre, p. 338.)

The same, condensed. 900 w. (In Engineering News, v. 39, p. 85.)

Describes condition of metals after exposure to the action of sea-water for several hundred years.

Mallet, Robert.

On the corrosion and fouling of iron ships. 60 p. 1872. (In Transactions of the Institution of Naval Architects, v. 13, p. 90.)

Discussion, 10 p.

"Catalogue of British patent inventions," p. 135, 17 p.

This information supplements that on pages 12, 13, 106, 275-277

Sabin, Alvah Horton.

Experiments on the protection of steel and aluminum exposed to sea-water. 8,000 w. 1896. (In Transactions of the American Society of Civil Engineers, v. 36, p. 483.)

Condition of plates with various preservative coatings after six months' immersion in sea-water.

Discussion and correspondence.

Experiments on the protection of steel and aluminum exposed to water. 5,000 w. 1899. (In Transactions of the American Society of Civil Engineers, v. 43, p. 444.)

Continuation of above experiments.

Discussion.

The same, condensed. (In Engineering News, v. 40, p. 54.)

PIPES

Committee report on relative corrosion of wrought-iron and steel pipes. 1,600 w. Dr. Ill. 1909. (In Plumbers' Trade Journal, v. 14. p. 214.)

The same, slightly condensed. 1,300 w. (In Heating and Ventilating Magazine, v. 6, p. 12.)

Report to American Society of Heating and Ventilating Engineers.

Tests indicate steel pipe of good quality to be as durable as wrought-iron pipe.

Corrosion of pipe in coal mines. 450 w. Ill. 1906. (In Iron Age, v. 78, p. 80.)

Results showing superiority of Spellerized steel pipes in the sulphur water of coal mines.

Dudley, William L.

Effect of coal gas on the corrosion of wrought-iron pipe buried in the earth. 1,100 w. 1908. (In Journal of the American Chemical Society, v. 30, p. 247.)

Experiments in earth saturated with coal gas, indicating that amount of corrosion is determined by the chlorin content in the earth.

Howe, Freeland, Jr.

Action of water on pipes. 5,000 w. 1908. (In Journal of the New England Water Works Association, v. 22, p. 43.)

Consideration of the nature of water and of iron pipe and of the electrolytic action that takes place.

Howe, Henry M. and Stoughton, Bradley.

Relative corrosion of steel and wrought-iron tubing. 20 p. Ill. 1908. (In Proceedings of the American Society for Testing Materials, v. 8, p. 247.)

Discussion, 15 p.

The same. (In Industrial World, v. 83, p. 1244.)

Believes that modern steel tubing is equal to wrought-iron tubing and that the prejudice against it is due to practical experience with older tubing.

This information supplements that on pages 12, 13, 106, 275-277

Knudson, Adolphus A.

Electrolytic corrosion of the bottom of oil tanks and of other structures. 4,300 w. Dr. Ill. 1908. (In Transactions of the American Electrochemical Society, v. 14, p. 189.)

Discussion, 900 w.

Corrosion of oil-tanks thought to be caused by galvanic action set up by the distribution of acid or alkaline electrolytes over the iron surface.

McAlpine, William J.

Corrosion of iron. 1,200 w. 1868. (In Transactions of the American Society of Civil Engineers, v. 1, p. 23.)

Cites instances of preservation of water-pipes, iron submerged in salt water, etc.

Mason, William P.

Action of water upon metals: tanks, pipes, conduits, boilers, etc. 19 p. Dr. 1902. (In his Water Supply, p. 394.)

Data compiled from various sources, giving references.

Rust in galvanized iron water-service pipe. 6,000 w. 1909. (In Metal Worker, v. 71, March 27, p. 48; April 3, p. 52; April 10, p. 45; April 17, p. 48; April 24, p. 39.)

Continued discussion, by letter, in reply to questions by either concerning the presence and prevention of corrosion in water-pipe.

Siebel, E. P.

Pitting of iron, particularly pipe; its causes and possible preventives. 3,000 w, Ill. 1909. (In National Engineer, v. 13, p. 192.)

Paper before the Chicago section of the Society of Brewing Technology.

Regards pitting as due to electrochemical decomposition in the presence of water and dependent upon the homogeneity of the material. Wrought-iron pipe considered more durable than steel pipe.

Speller, Frank N.

Wrought pipe-threading and relative durability of steel and iron. 3,000 w. Dr. Ill. 1905. (In Journal of the Canadian Mining Institute, v. 8, p. 46.)

The same. (In Iron Age, v. 75, p. 741.)

Review and illustrations of United States Navy Department tests on pitting. Experiments by National Tube Co., showing that, in resistence to corrosion, common iron and Bessemer steel are both slightly superior to charcoal iron.

Stewart, A. W.

Corrosion in metal pipes on board ship. 6,200 w. 1903. (In Transactions of the Institution of Naval Architects, v. 45, p. 183.)

The same, abstract. (In Engineer, London, v. 95, p. 374.)

Discussion.

Considers the action of impurities on the pipes, especially of chlorine and organic impurities.

This information supplements that on pages 12, 13, 106, 275-277

Thomson, T. N.

Relative corrosion of wrought-iron and soft steel pipes. 2,800 w. Dr. Ill. 1908. (In Heating and Ventilating Magazine, v. 5, p. 15.)

The same, slightly condensed. 2,500 w. (In Iron Age, v. 81, p. 434.)

See also letter by G. Schumann, p. 520.

Paper before the American Society of Heating and Ventilating Engineers.

Conclusion from experiments is that "plain steel pipe is more durable than plain wrought-iron pipe when used to convey hot water and subject only to internal corrosion."

Wrought-iron pipe versus steel pipe. 1,300 w. Dr. 1908. (In Heating and Ventilating Magazine, v. 5, p. 8.)

Contains extracts from a pamphlet published by the Reading Iron Co., claiming that wrought-iron is the more durable.

BOILERS

Baucke, H.

Beitrag zur metallographie des flusseisens. 1,600 w. Ill. 1899. (In Baumaterialienkunde, v. 4, p. 349.)

The same, in French. (In Baumaterialienkunde, v. 4, p. 349.)

The same. (In Stahl und Eisen, v. 20, pl. 1, p. 260.)

The same, condensed translation. 600 w. (In Journal of the Iron and Steel Institute, v. 57, p. 427.)

Microscopic examination of badly corroded boiler tubes.

Christie, William Wallace.

Corrosion. 35 p. Ill. 1906. (In his Boiler-waters, p. 68.)

Treats rather fully the corrosion of boilers, the action of different feed-waters and the dangers of pitting.

Churchill, W. W.

Preservation of surface condenser tubes in plants using salt or contaminated water circulation. 3,000 w. 1906. (In Science, v. 47, p. 405.)

The same. (In Power, v. 26, p. 598.)

Paper before the American Association for the Advancement of Science.

Considers the prevention of electrolytic corrosion. Author presents Oliver J. Lodge's views on electrolytic condition and Faraday's laws of electrolysis as a basis for his views.

Ford, John D.

Corrosion of boiler tubes. 5,200 w. Ill. 1904. (In Journal of the American Society of Naval Engineers, v. 16, p. 529.)

The same, condensed. 1,000 w. (In Iron and Steel Magazine, v. 10. p. 349.)

Extensive experiments made for the United States Navy Department at the laboratory of the National Tube Co., McKeesport, to determine relative corrodibility of lap-welded Bessemer steel, lap-welded iron, seamless cold-drawn steel, and seamless hot-drawn steel boiler tubes.

Frémont, Ch., and Osmond, F.

Les sillons de corrosion dans les toles de chaudières à vapeur. 4,200 w. Ill. 1905. (In Revue de métallurgie, v. 2, p. 75.)

Investigation of cause of lines of corrosion in boiler plates.

Gesellschaft fur Hochdruck-Rohrleitungen.

Wasserbeschaffenheit und korrosionen. 4,000 w. Ill. 1909. (In its Rohrleitungen, p. 127.)

Considers action of water on iron, especially of boiler-waters, and methods of protection.

Gibbons, W. H.

Physical reasons for rapid corrosion of steel boiler-tubes. 800 w. Ill. 1895. (In American Engineer and Railroad Journal, v. 69, p. 157.)

Considers difference in corrodibility of tubes made from the "top" and the "bottom" of an ingot, with its application to the relative corrosion of steel and charcoal iron.

Kirtley, William.

On the corrosion of locomotive boilers and the means of prevention. 8,800 w. Ill. 1866. (In Proceedings of the Institution of Mechanical Engineers, v. 17, p. 56.)

Considers corrosion due both to chemical action of water and mechanical action of strain. The trouble may be obviated by removing one of these causes, i. e., by proper boiler design, eliminating springing at joints, etc.

La Coux, H. de

Eaux corrosives et incrusto-corrosives dans les générateurs de vapeur. 14,500 w. 1899. (In Le Génie Civil, v. 36, pp. 117, 139, 149.)

Substances causing corrosion and means of prevention.

This information supplements that on pages 12, 13, 106, 275-27

McBride, James.

Corrosion of steam drums. 8,000 w. Ill. 1891, 1894. (In Transactions of the American Society of Mechanical Engineers, v. 12, p. 518; v. 15, p. 1087.)

Includes lengthy discussion.

Norris, W. J.

Corrosion in steam boilers. 5,000 w. 1882. (In Transactions of the Institution of Naval Architects, v. 23, p. 151.)

Disagrees with theories of galvanic action; production of hydrochloric acid in boiler by decomposition of water; action of fatty acids produced by decomposition of lubricants, etc. Ascribes all boiler corrosion to simple oxidation by presence in water of free oxygen derived from the air.

Palmer, J. Edward.

Corrosion of steel boiler tubes on vessels fitted with turbine engines. 1,000 w. 1907. (In Journal of the American Society of Naval Engineers, v. 19, p. 54.)

The same. (In Engineering News, v. 57, p. 426.)

Corrosion caused by copper deposits in the tubes, carried over by the steam from the bronze turbine blades.

Paul, James Hugh.

Corrosion in steam boilers. 20 p. Ill. 1891. (In Transactions of the Society of Engineers, v. 31, p. 147.)

Chemical properties of iron; manufacture of boiler plates; corrosive natural waters; artesian well waters; corrosion in marine boilers; action of zinc.

Discussion.

Rinne, H.

Kesselmaterial und kesselkorrosionen. 5,000 w. Dr. 1904. (In Stahl und Eisen, v. 24, pl. 1, p. 82.)

Considers the corrosion of boiler tubes of different qualities of iron and the influence of other conditions.

Worthington, Walter F.

Corrosion of boiler tubes in the United States Navy. 3,000 w. Pl. 1900. (In Journal of the American Society of Naval Engineers, v. 12, p. 589.)

Causes of corrosion are discussed, especially from the action of the different impurities in feed water.

This information supplements that on pages 12, 13, 106, 275–277

PLAIN FACTS ABOUT "NATIONAL" PIPE[1]

By F. N. SPELLER[2]

A large proportion of the pipe manufactured in this country is used on plumbing and heating contracts. The leading members of these trades should be able to choose intelligently between the various grades of pipe on the market today, to be able to advise others, and to give exact reasons for preferring this or that brand. The time is past when a haphazard opinion will satisfy the engineer, the architect, or the man who is paying the bills.

Doubtless there are numerous master plumbers and steamfitters who wish to obtain authentic information on pipe, but such as there is in print is scattered and not easily available to the busy, practical man. To meet the many questions which are asked, there are condensed here some essential facts relating to modern welded pipe.

Up to about twenty-seven years ago hand-puddled iron was exclusively used; the quantity required was comparatively small. Skilled puddlers were plentiful, so there was no trouble in supplying the demand of that time. For some years after this, with the introduction of steel as the basic material for pipe, there were two classes of pipe known to the trade—iron and steel. Now there are almost as many grades as there are manufacturers, there being several varieties of iron on the market, and the same is true of steel pipe. Specifications of the large users of pipe, such as the government, railways, etc., now usually call for "iron" or "steel," and then specify particularly the quality or brand desired, so that good pipe only can be furnished. This practice has resulted from the fact that there is much more difference between the various grades of wrought iron and the different makes of steel than there is between iron and steel as a class.

Many plumbers and fitters still express a preference for wrought iron. This may be based on early experience with steel, or only as a matter of habit, or prejudice. The basis of such opinions will hardly justify the honest, practical man of today, who recognizes a marked difference in the quality of these products as made today compared with twenty-odd years ago, in obstinately adhering to wrought iron or blindly refusing to recognize the clear merit of properly made steel.

The question of threading is sometimes referred to. This is a mechanical problem depending more on correctly made dies, the pipe being made up to weight and of correct diameter, than on the material. An important investigation reported in the Proceedings of the American Society of Heating and Ventilating Engineers, 1906, by a practical leader in plumbing and heating[3], concludes: "It (the test) shows that the power required to thread mild-steel pipe with the new die is not much

[1]Reprinted from Plumbers' Trade Journal, Steam and Hot Water Fitters' Review, December 15, 1913; January 1 and 15, and February 1, 1914.

[2]Metallurgical Engineer, National Tube Company, Pittsburgh, Pa.

[3]T. N. Thomson, Member A. S. of H. V. Eng. and Principal of Sanitary Plumbing, Heating, and Ventilation, International Correspondence Schools, Scranton, Pa.

This information supplements that on pages 12, 13, 106, 275-277

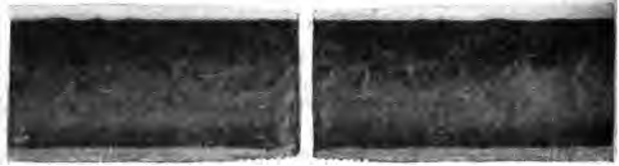

Fig. 200.—*Comparative corrosion of adjacent hot water supply pipes. Left, wrought-iron; right, steel.*

more than that required to thread wrought iron pipe with the same die, and much less than the power required to thread wrought iron pipe with the common die under identical conditions."

The same investigator shows clearly that many of the wrought iron pipes threaded with a common type of die took more power than many of the steel, and although on the average the iron took slightly less power to thread—the steel was more uniform and gave a stronger thread.

A series of tests are now being conducted to determine the actual power required to thread "NATIONAL" pipe with length of standard stock. The tests are yet incomplete, but more than a thousand threads cut to date indicate the average power required to thread "NATIONAL" pipe to be about as follows, using ordinary lead-screw type of hand stock and properly designed dies: 1-inch, 45 lbs.; 1¼-inch, 65 lbs.; 1½-inch, 75 lbs.; 2-inch, 100 lbs.

The corrosion question is one of the most complicated in its nature and very properly concerns all who have anything to do with pipe. Most practical men have observed a great difference in the life of pipe—that used in a hot water heating system, for example, seems to last indefinitely, while in most hot water supply systems, under some conditions, the same class of pipe will only last a few years, depending on the volume of water used, temperature, method of heating, etc. These are all factors of vital importance, and yet are rarely considered by the practical man. In fact, the man who is most ready with his opinion on this question of the life of iron and steel pipe frequently not only ignores these essential conditions, but, as a rule, cannot distinguish wrought iron from steel, or has rarely taken the trouble to try. As an illustration of this, some few years ago an investigator of international reputation (Prof. H. M. Howe, of Columbia University, New York City) studied this question of corrosion and attempted to reconcile the conflict between the various opinions and actual results. He has shown that it was easy to explain the prevailing opinion regarding steel, but no one could explain away the actual facts.

The following abstact from a paper by Professor Howe[4] is given in full as being of particular interest to plumbers:

"*Competence of Plumbers to Distinguish Steel from Iron Tubing.*—One of us submitted several pieces of tube which he knew by his own etching.

[4] "The Relative Corrosion of Steel and Wrought-Iron Tubing"—H. M. Howe and Bradley Stoughton. (Proceedings of the American Society for Testing Materials. Volume 8, 1908.)

This information supplements that on pages 12, 13, 106, 275-277

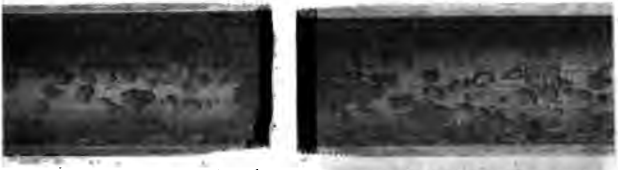

Fig. 201.—*Boiler feed water pipes. Corrosion of the steel shown at left, that of the wrought iron at right.*

tests to be steel, and others which he knew to be wrought iron, to four different plumbers and asked them to tell, by cutting with a die or otherwise, which were steel and which iron. One plumber, after making several attempts, admitted that he could not tell. The other three reached the results given herewith in Table A. In every case the plumber made the tests with his own dies.

Plumber No.	No. of Tubes Tested Iron	No. of Tubes Tested Steel	No. Reported Right Iron	No. Reported Right Steel	No. Reported Wrong Iron	No. Reported Wrong Steel	Percentage of Errors Iron	Percentage of Errors Steel
1	11	11	6	10	5	1	45	9
2	6	6	0	6	6	0	100	0
3	6	6	0	6	6	0	100	0

Table A.—*Trustworthiness of threading test with common dies for distinguishing steel from iron tubing.*

"From the last two columns of Table A it will be seen that, while plumber No. 1 came a little nearer the truth than if he had simply decided by tossing a penny, Nos. 2 and 3 came no nearer than if they had followed that method. No. 3, whom one of us knows well to be an unusually intelligent mechanic, took three-quarters of an hour to test the twelve tubes, and included in his test very careful inspection for blisters and other indications, and also testing the ductility of the chips. He and his helpers were very sure that the power required for cutting the steel was very much greater than that needed for cutting iron, and that steel chips were very much more brittle than iron chips. He was perfectly confident that all of the tubes were steel, though, in fact, six of them were iron.

"This goes to show that this test of threading with a die, supposed to distinguish steel from wrought iron by the greater pressure needed for threading the former, the only ready test which the plumber has, is not trustworthy. This had been shown by Principal Thomson in his paper on 'Power Required to Thread, Twist and Split Wrought Iron and Steel Pipe.'[1] He found that while on the average of all his cases threading needed more power in case of steel than of iron, yet in no less than five out of the nine sets of tests the easiest threading steel pipe needed less power than the hardest threading iron pipe. For instance, with one type of dies, the pressure needed for threading was only 100 lbs. in case of two of his four 1-inch steel pipes, but was materially greater in case of all eight of the 1-inch iron pipes tested, and was between 120 and 123 lbs. in case of six of them.

[1]Paper read before twelfth annual meeting, A. S. H. V. Engineers. 1906.

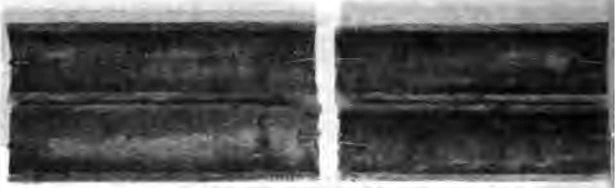

Fig. 201.—*Pipe removed from hot water supply in New York City baths. Two specimens at left are iron, at the right, steel.*

"Again, trustworthy reports have been made to us of cases, first, in which intelligent and experienced engineers, to whom samples of steel and iron pipe have been submitted, have decided promptly and positively, but incorrectly, as to which was iron and which steel; and second, of cases in which pitted pipes, though reported to be steel, have proved to be iron."

The illustrations, Figs. 200 and 201, show comparative corrosion and are from photographs (unretouched) of adjacent boiler feed water pipe as found in service, the steel and wrought iron pipes were separated by a coupling only, and are representative of a large number of similar examples, collected during investigations by Wm. H. Walker, Ph. D., in 1911. The investigations led him to the following conclusion[a]: "*These results again demonstrate that, taken on the average, there is no difference in the corrosion of iron and steel pipe.*"

It would be useful if each plumber and steamfitter who is inclined to consider this subject carefully would overhaul his experience and ask himself if he has positively identified the pipe with which he has had trouble and furthermore make a personal test of his ability to distinguish iron from steel. This is plainly of fundamental importance, as no confidence can be placed in opinions which are not based on a certain knowledge of the material to which the opinions refer. How many of the opinions glibly spoken or boldly printed by the wrought iron interests are correctly founded?

Many loose statements in this connection are made, but when run down or when actual evidence is requested, such evidence dissipates into thin air. A typical experience in this connection may be quoted: Page 250 of the Proceedings of the American Society for Testing Materials, Volume 8, 1908, contains paper "The Relative Corrosion of Steel and Wrought Iron Tubing," by Henry M. Howe and Bradley Stoughton, and we quote from page 250 as follows:

"This is all the evidence which we have found, and received permission to cite, though we have asked manufacturers prominently and financially interested in showing that steel is worse than iron to give the addresses of those who could give us evidence. None of that which we have found, but have not yet received permission to cite, is unfavorable to steel."

[a]Abstract from paper read December 13, 1911, before New England Water Works Association.

This information supplements that on pages 12, 13, 106, 275-277


Fig. 203.—*Portion of steel pipe after exposure of 64 weeks in aerated cold water—U. S. Navy test.*

Reports rendered on pipe, iron and steel exposed under the same conditions of service, show no practical difference in durability. Up to a few years ago such tests constituted all the definite information obtainable on this important question. Lately, however, many cases have come to light where iron and steel pipe have been accidently installed together for several years, and a direct comparison of these materials under identical conditions is thus made possible. Several independent investigations of such cases have been made which include probably 150 comparisons of iron and steel pipe. It is not surprising that nearly all old heating and supply systems put in 10 or 12 years ago show this mixture of pipe, as most of the jobbing houses at that time carried two stocks and the different makes of pipe were not identified by permanent marks.

The supposed superiority of wrought iron pipe has been used as a talking point to such an extent by wrought iron manufacturers, in order to obtain an unwarranted premium in price, that the facts referred to should be welcomed by the best class of plumbers and steamfitters, and that with the possession of this information many may be led to investigate these facts for themselves. It is quite easy for anyone to distinguish iron from steel by fracturing the metal or filing across the pipe.

The pipes shown in Fig. 202 were removed from hot water supply lines in New York City baths during investigations instituted and conducted by Prof. Ira H. Woolson, formerly of Columbia University, now consulting engineer of the National Board of Fire Underwriters, who arrived at the following conclusion[7]: "*In my judgment, from the evidence collected, there was absolutely no difference in the corrosion of the two classes of pipe—that is, iron and steel. They appear to be equally susceptible to the attack.*" These illustrations are from unretouched photographs.

The illustrations, Figs. 203 and 204 (also from unretouched photographs), indicate the corrosive condition of steels and charcoal iron lap welded tubes after an exposure of sixty-four weeks in National Tube Company's laboratories. These tests were conducted under the direction of the Bureau of Steam Engineering of the United States Navy[8], and show ample evidence that the two materials are equally durable under corrosion.

[7]Abstract from paper published in Engineering News, December 8, 1910, page 630.

[8]Abstract from article prepared by Rear Admiral John D. Ford, U. S. N., and published in Journal of Society of Naval Eng., May, 1904.

This information supplements that on pages 12, 13, 106, 275-277

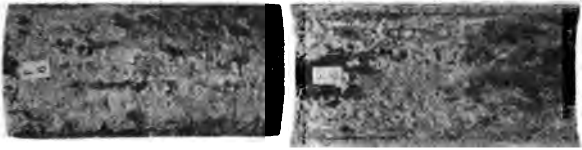

Fig. 204.—*Charcoal iron specimens subjected to 64 weeks in aerated cold water—U. S. Navy test.*

Pipe steel carries 99.5 per cent metallic iron; wrought iron carries 97.5 per cent metallic iron and both are made from the same ore. The metal is separated from oxygen and other impurities, in each case at the expense of outside energy, and tends to return to its original, more stable condition when exposed to moisture and air. The various forms of steel or iron are in a sense like a coiled spring, all having the common tendency to return to their original form as soon as the restraining influence is removed; a pipe may last fifty days or fifty years or more, according to its surroundings. Some steel lines examined after 20 years' service appear to be as good as when laid—naturally, there are some isolated cases where wrought iron has lasted much longer, but this proves nothing.

It is easy for one interested in wrought iron manufacture to refer to isolated cases of long life in the early history of pipe. If this is the standard by which pipe should be judged under modern conditions the quality of the iron must have sadly deteriorated. How many reputable plumbers will advise using galvanized wrought iron in the hot water supply lines of an important building nowadays?

A number of cases have been investigated (many in and around New York City) and are tabulated herewith. (Table B.) No mention is made of many more examples of corrosion investigated where there was no mixture of material, as there would be no comparison possible and the results would be misleading. It is sufficient to say that where conditions are favorable to wrought iron they are favorable to steel, and the reverse is also equally true.

To sum up, it should be borne in mind by all thoughtful members of the trades handling pipe that:

1. Steel pipe is no longer an experiment, but has a record of 25 years' service—and in that time has increased in use to about ninety per cent of the entire production.

2. Opinions should be based on a real personal knowledge, taking nothing for granted—the average user of pipe has abundant opportunity to investigate for himself.

3. All the comparisons which have been made in service covering the average life of pipe today indicate clearly that there is no difference in life between iron and steel pipe as a class, although there is something to say between the various makes of each class.

This information supplements that on pages 12, 13, 106, 275-277

4. All reputable makes of pipes are now marked so that substitution or mistakes are no longer possible. The fact that so much steel pipe has been used in the past, supposedly as wrought iron, is very significant in the light of real experience.

5. It is advisable to inquire carefully into the basis of statements made on the general question of iron and steel pipe—hearsay and supposition are dangerous substitutes for real experience in such matters.

In summary, the conclusions of the following authorities who have studied this question, are quoted with references so that the tests on which these conclusions are based can be carefully studied if desired:

"The Corrosion of Iron and Steel."—Alfred Sang. (Proceedings The Engineers Society of Western Pennsylvania, January, 1909):

"The opinion one is led to form . . . is . . . that properly protected steel and iron rust to about the same extent, the steel doing so more uniformly."

"The Relative Corrosion of Wrought Iron and Soft Steel Pipes."—T. N. Thomson. (Proceedings American Society of Heating and Ventilating Engineers, Volume XIV, 1908):

"Therefore, a rational deduction to draw from the preceding facts is that steel pipe is more durable than plain wrought iron pipe when used to convey hot water and subject only to internal corrosion. I know that the above summary is not in perfect harmony with the opinions of many engineers and contractors, but I can only record the facts as they are found to be without comment."

"Report of Committee on Corrosion of Wrought Iron and Steel Pipes." (Proceedings A. S. H. & V. Engineers, Vol. XVI, 1910):

"This test checks up well with the aforesaid 1908 paper, and we believe demonstrates that modern steel pipe of good quality is at least as durable as modern strictly wrought iron pipe of good quality, and is very much superior to a poor quality of wrought iron in this class of work."

"In closing we desire to call special attention to the fact that we find it is not safe to accept reports regarding the corrosion of wrought iron and steel pipes without first identifying the materials, because so many engineers cannot ordinarily distinguish the difference between them."

"Corrosion of Hot Water Piping in Bathhouses."—Ira H. Woolson. (Engineering News, Dec. 8, 1910, page 630):

"In my judgment, from the evidence collected, there was absolutely no difference in the corrosion of the two classes of pipe. They appear to be equally susceptible to attack from what the samples show."

"The Relative Corrosion of Iron and Steel Pipe as Found in Service." —Wm. H. Walker, Ph. D. (Journal of New England Water Works Association, March, 1912):

"These results again demonstrate that, taken on the average, there is no difference in the corrosion of iron and steel pipe."

"Street Main Standards."—G. I. Vincent, Chief Engineer Des Moines Gas Company. (Proceedings American Gas Institute, 1913):

"The so-called genuine wrought iron pipe commands a premium of about 15 per cent over steel. Its additional value is not apparent. Spellerized steel pipe is probably as durable as the wrought iron."

This information supplements that on pages 12, 13, 106, 275-277

TABLE B

SUMMARY OF RESULTS OF INVESTIGATIONS OF THE CORROSION OF IRON AND STEEL IN ACTUAL SERVICE

No.	Date	Locality	Length of time pipe lines were installed	Character of service	Authority	Number of comparisons found	Average of deepest pits: Wr. Iron	Average of deepest pits: Steel	References for details and remarks
1	1910	New York City bath-houses	3 yrs. and over	Hot water supply service	Prof. Ira. H. Woolson, Columbia University	89 samples secured, of which 17 were wrought iron and the remainder steel	Equal 100%	100%	Engineering News, Dec. 8, 1910, p. 630; "NATIONAL" Bulletin, No. 2. This was a test of iron and steel pipe in actual service continued to destruction.
2	1910	Frick Coke Co. power plants	6 mos. to 7½-8 yrs., varying with the comparisons secured	Boiler feed water lines	Research Laboratory National Tube Company	21 lots comprising 52 samples, of which 26 were iron and 26 steel	.112"* 100%	.108"* 96%	Engineering Review, April, 1911; "NATIONAL" Bulletin No. 3; American Society Heating and Ventilating Engineers, 1911. Pipe samples secured from lines in actual use. In 22 cases of adjacent iron and steel pipes in same lines, 13 comparisons favor steel and nine iron.
3	1911	Cresson, Pa., Coal Fields	6 mos. to 10 yrs., varying with the comparisons secured	Hot and cold water boiler feed lines; pump discharge lines	Research Laboratory National Tube Company	9 comparisons of steel and iron were found together	.100"* 100%	.085"* 85%	Pipe samples secured from lines in actual use. In 9 cases of adjacent iron and steel pipes found in the same lines, 4 comparisons favor steel and 2 iron; in 3 cases the steel and iron are equally corroded.

NOTE.—Depth of pitting in wrought iron samples considered as 100% in all cases. *Calculated from the deepest pit in each sample.

This information supplements that on pages 12, 13, 106, 275-277

TABLE B (Concluded)

SUMMARY OF RESULTS OF INVESTIGATIONS OF THE CORROSION OF IRON AND STEEL IN ACTUAL SERVICE

No.	Date	Locality	Length of time pipe lines were installed	Character of service	Authority	Number of comparisons found	Average of deepest pits: Wr. Iron	Average of deepest pits: Steel	References for details and remarks
4	1911	Allegheny General Hospital	Between 7 and 8 years	Hot water supply service	Research Laboratory National Tube Company	69 samples from hot water lines, 42 wrought iron and 27 steel	.105"* 100%	.105" 100%	Conditions those of actual service, and pipe was tested to destruction. In 13 cases of adjacent iron and steel pipes found in same lines, 7 cases favor steel and 6 iron.
5	1911	New England Investigation	2 yrs. to 17 yrs., varying with the comparisons secured. Average 9 yrs.	Hot and cold water, live and exhaust steam, brine boiler, blow-off lines, etc.	Dr. W. H. Walker, Director Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology	64 comparisons of iron and steel found together in hot water and steam lines, etc.	.069"* 100%	.063"* 91%	Journal of the New England Water Wks. Ass'n, March, 1912; Engineering News, Dec. 21, 1911; Journal of Industrial and Engineering Chemistry, June, 1912. In 64 comparisons of iron and steel pipe found, 20 favor steel, 18 favor iron, 9 show equal corrosion of iron and steel, and in 17 cases the corrosion was negligible.
6	1913	New York City Hotel Investigation	6 to 10 yrs.	Hot water supply and steam return lines	Dr. Wm. Campbell, Columbia University, co-operating with Research Laboratory, N. T. Company	From 60 samples 9 comparisons of iron and steel were found	.095" 100%	.067" 70.5%	Conditions those of actual service, pipe used to destruction. The iron samples failed in 20 spots; the steel failed in 2 places, due to pitting.

NOTE.—Depth of pitting in wrought iron samples considered as 100% in all cases. *Calculated from the deepest pit in each sample.

This information supplements that on pages 12, 13, 106, 275-277

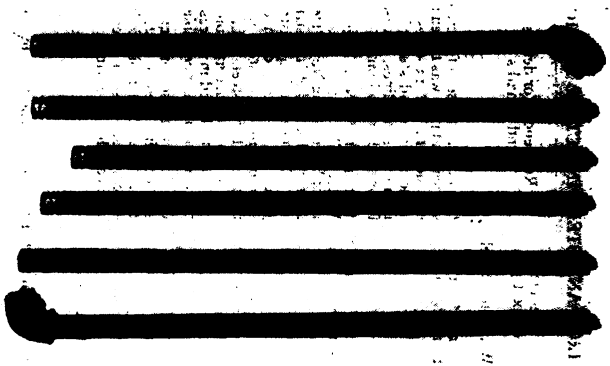

Fig. 205.—*Six specimens of "NATIONAL" pipe which were a part of a warm water line in a well known conservatory.*

These illustrations, Figs. 205 and 206 (from unretouched photographs), indicate comparative corrosion, especially in the form of pitting. These sections of pipe, which formed a portion of the warm water feed lines in a nationally-known conservatory, were installed at the same time, worked under same conditions and length of service, and show conclusively that steel pipe is in this case superior to wrought iron. The chief engineer writes: "The wrought iron was found to be badly pitted and rotten, while the steel was uniformly corroded, with no pits."[1]

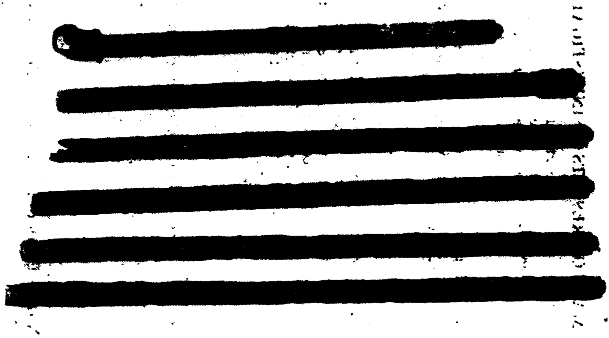

Fig. 206.—*Wrought-iron pipe samples which had served under identical conditions as those shown in Fig. 205.*

[1] *This information supplements that on pages 12, 13, 106, 275-277*

Fig. 107.—*The samples of pipe in the upper part of photograph are of wrought-iron, while those below are of "NATIONAL" Spellerized steel. All were obtained from a Pennsylvania coal mine, after being exposed together for a period of time.*

This information supplements that on pages 12, 13, 106, 275-277

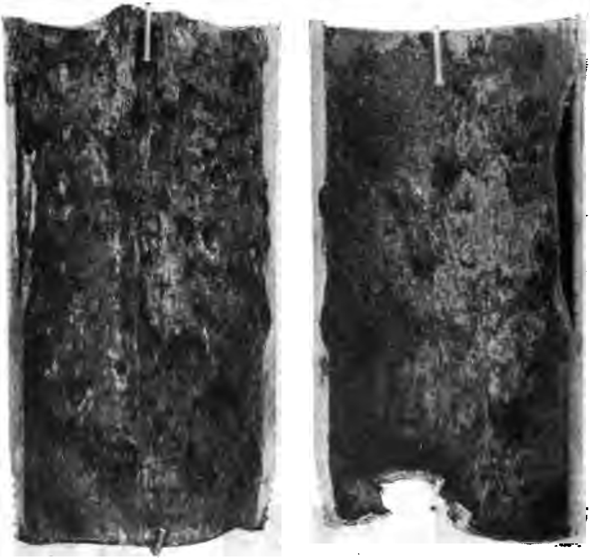

Fig. 208.—*Wrought-iron pipe samples in New York hotel hot water supply.*

The illustrations clearly show the comparative corrosion of wrought iron and mild steel pipe. It has been the aim of the writer to reproduce representative comparisons of iron and steel pipe in actual service, not only in one or two phases of use, but from a wide and varied field, which demonstrates that this article is not only applicable to the plumbing and steamfitting trade, but for all uses where pipe, made from iron as basic material, is necessary.

In the preceding text it was endeavored, by explanations and photographs, to set forth the relative merits of both steel and wrought iron pipe. In every case the specimens were obtained where same had been in use under identical conditions. The writer believes that readers will agree that these tests have not substantiated the often made claim advanced by the wrought iron interests concerning the superiority of their product.

In the accompanying pictures further evidence of the durability of steel pipes as compared with wrought iron is given.

These pipes (shown in illustration), Fig. 207, were used in running coal mine water in Western Pennsylvania for the same length of time, and under identical conditions, and the photographs show clearly the comparative corrosion of the two materials. Note that the disintegration is considerably more uniform on the Spellerized steel than on the wrought iron pipe.

This information supplements that on pages 12, 18, 106, 275-277

Fig. 209.—*Steel pipe used under same conditions as Fig. 208.*

Figs. 208 and 209 and those succeeding (from photographs, unretouched) show specimens of wrought iron and steel pipe. These comparisons were taken from adjacent lines of the same system and were used an equal length of time in the hot water supply of one of New York City's prominent hotels. These and other comparisons were secured during a recent pipe investigation in New York City, conducted with the co-operation of Dr. Wm. Campbell, Columbia University. Note excellent condition of the "steel" after six years' service. This again demonstrates the superior merits of steel as material for pipes.

This information supplements that on pages 12, 13, 106, 275-277

Fig. 210.—*Other wrought-iron pipe used under same conditions.*

Note Figs. 210 and 211 in every instance the even pitting of the steel as against that of wrought iron. It is maintained that steel pipe is as generally durable as wrought iron. The photographs are taken from representative samples.

Fig. 211.—*Two sections of steel pipe from hot water supply.*

This information supplements that on pages 12, 13, 106, 275-277

Fig. 212.—*Wrought-iron pipe obtained from hot water supply line in hotel.*

Reference to Figs. 212 and 213 show other specimens from the same hot water supply system as the others. Hot water supply lines present severe service conditions and extensive corrosion usually takes place. In conclusion it is evident upon comparison that the steel pipe has withstood disintegration fully as well as the wrought iron.

Fig. 213.—*Steel pipe taken from same line as Fig. 212.*

This information supplements that on pages 12, 13, 106, 276-277

THE DESIGN OF HOT-WATER SUPPLY SYSTEMS TO MINIMIZE CORROSION[1]

By F. N. SPELLER[2]

Suggested Design—In a paper on the "Durability of Welded Ste Pipe[3]," reprinted and commented upon in Engineering News, March 2 1911, there were discussed the results of investigations on the relativ corrosion of iron and steel in service, and the influence of the dissolve gases (oxygen and carbonic acid) in water and a scheme was suggeste for rendering the water practically harmless by removing the air afte heating. So far as the writer is aware, however, no system has yet bee designed with this as the main object.

Comparisons on Pitting—In the paper referred to the writer pointe out first, that the superiority claimed for "genuine" wrought iron pip had not been proved by comparative tests in service; on the contrary, th numerous cases which are on record (and which have been largely adde to since that time), show conclusively that where both iron and stee have been used together in water lines, the wrought iron pits just a badly as the steel under the same conditions. A number of such comparisons were compiled by the writer for the International Congress for Testing Materials last September.[4]

Authorities Agree—We need not again go into the cause of thi pitting, which is now generally recognized to be due to galvanic actio between impurities on the surface of the metal, especially mill scale an rust. The leading authorities now seem agreed that corrosion is practicall independent of the composition of the metal, provided it is reasonabl uniform (as the steel used for welded pipe must necessarily be if it weld without developing injurious defects).

In order to have continued corrosion, oxygen must be present in solution the removal of this oxygen has been found to greatly lessen corrosion. In his recent report of researches along this line, Dr. W. H. Walker, directo of the research laboratory of the Massachusetts Institute of Technology, describes one of his experiments thus:[5]

> "Two coils made up from pieces taken from the same length of pipe were each fed with water from the same source at the same temperature. In one case the water was heated to 85 degrees Cent. in an open tank, while in the other the water was heated to the same temperature in a closed tank. The feed water contained

[1]Reprinted from Engineering News, February 13, 1913, page 294.

[2]Metallurgical Engineer, National Tube Company, Frick Bldg., Pittsburgh, Pa.

[3]Proceedings, American Society of Heating and Ventilating Engineers, 1911.

[4]"Comparative Service Obtained with Wrought-Iron and Soft Steel Pipes as Water Lines in the United States," Proceedings, International Association for Testing Materials, 1912, XXIV, 4.

[5]Engineering News, December 21, 1911; Journal of New England Water Works Association, March, 1912; Journal of Industrial and Engineering Chemistry, July, 1912.

This information supplements that on pages 12, 13, 106, 275-277

on the average 5.85 c.c. of oxygen per liter, and passed through each coil at the rate of ½ gal. per min. After running 1750 hr., the coil fed with water heated in an open tank had lost 22 grams, while the coil fed with water heated in a closed tank had lost 155 grams. In neither case was the oxygen completely removed; if the water in the open tank had been gently boiled, corrosion in the coil fed with this water would have been completely prevented."

These results again indicate that the intensity of conditions has much more to do with corrosion than anything else; so much so that the same material used as a pipe in a hot-water heating system, where the water is practically free from oxygen and unchanged, should last fifty years or more, while in a closed hot-water supply system it may only last five or six years.

This principle of heating and freeing the water from dissolved oxygen, by which it seems possible to prolong the life of standard welded pipe several times, is surely worthy of careful consideration in designing piping systems which are subject to corrosion.

A recent investigation, undertaken by the writer with the assistance of some of his research staff, has developed interesting points in regard to the present practice of laying out hot-water supply systems. The influence of the arrangement of the piping on corrosion seems to be quite marked, depending on whether the gases are liberated before the water enters the distributing system or not, although the separation of these gases is only partially accomplished under the best conditions. Large installations were considered, such as hotels, large apartments and office buildings where, on account of the great quantity of hot water used, serious trouble would be most likely to occur.

Classes of Systems—The hot-water supply systems found in these buildings differed in many details, but may be divided into two classes, according to whether the main vertical distributing lines are supplied from a common horizontal main in the basement, or from a similar horizontal distributing main above the level of the highest fixture near the roof. These types of installations are illustrated, diagrammatically and without detail of any kind, in Figs. 214 and 215.

Underfed System—The underfed system is characterized by a number of independent risers and return-risers, each supplying a separate section of the building. These risers are rarely vented at the top and consequently the hot water is always supersaturated with air when the system is in continuous use. This is a good example of the closed type of heating so designed that it would be very difficult, if not entirely impracticable, to vent so as to remove the gases before the water is used.

Overhead Open System—The system illustrated by Fig. 215, on the other hand, is radically different in this respect, and to a considerable extent, although not completely, allows the escape of dissolved gases to the atmosphere at the highest point before the water is distributed throughout the system and returns to the heater. Since all the water used passes up through one riser a vent must be provided, otherwise trouble due to

This information supplements that on pages 12, 13, 106, 275-277

Two types of hot-water supply systems.

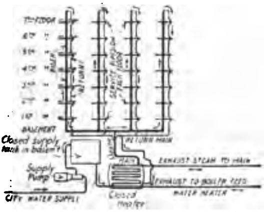

Fig. 214.—*Underfed closed system.*

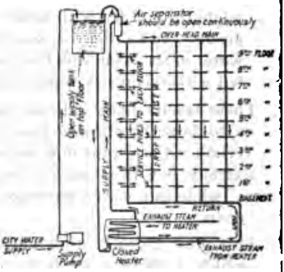

Fig. 215.—*Overhead open system.*

the trapping of air in the upper lines would probably be experienced. It would seem to be a very simple matter to almost completely free the water from dissolved gases with such a system, by putting a simple air-separating device at the upper end of the main riser, as indicated at the point A in Fig. 215. To obtain the best results, the water should be heated to about 200 deg. Fahr., using an inter-cooler, if desired, to reduce the temperature after leaving the air-separating chamber.

The writer has discussed only general principles affecting the life of the piping system; the details necessary to carry out these principles in practice, will, of course, require thought and expert knowledge of design on the part of practical engineers having to do with heating and plumbing.

With pure water, such as is supplied to New York City for example, the percentage of dissolved gases is proportionately high, so that the benefit to be expected from such treatment when thoroughly carried out and maintained would probably be very marked.

Several cases investigated, where large systems of hot-water supply lines have suffered serious damage in six or eight years, have all occurred in buildings equipped with closed heating systems. So far, we have not found serious trouble in systems of the open type where any attention has been given to venting, although the significance of adequate venting of such systems does not seem to be appreciated by architects and engineers, for in some cases, where vents were provided, the practice was to keep them closed except when trouble with air-hammer was experienced.

Engineers and architects have perhaps hesitated to make changes in the closed system of heating without more practical evidence of a substantial character, the scientific study of corrosion being all new ground. The writer hopes to see a free discussion, on the part of those who have most experience in such work, so that the best system of design may be developed for such installations with due regard to prevention of corrosion.

This information supplements that on pages 12, 13, 106, 275-277

TESTIMONY AS TO RELATIVE CORROSION OF WROUGHT IRON AND STEEL PIPE

Notwithstanding the fact that nearly 90 per cent of the pipe made and sold in the United States at the present time is manufactured from mild steel, still there are certain people who cling to the idea that wrought iron is more durable.

For twenty-eight years steel pipe has been marketed and used side by side with wrought iron pipe. It is entirely natural, therefore, that many cases have been found where the two materials have been serving in the same pipe line, under same service conditions, and for the same length of time, thus offering an ideal comparison of the relative life of the two kinds of pipe.

In order to present the facts as we have found them in the proceedings of various technical bodies, in engineering books, and similar sources, the following excerpts are quoted as convincing evidence that it is the general opinion (based on actual experiences) of unbiased authorities that "there is little or no difference in the relative life of wrought iron and steel pipe."

TESTS

Thomson—Prof. T. N. Thomson, in March, 1906, installed alternate pipes of the two metals in a hot-water line, and at the end of a year discovered that steel pipe had approximately 7½ per cent longer life than wrought iron under such conditions. *See "NATIONAL" Bulletin No. 4.* (A. S. H. & V. Engineers, 1906.)

In a similar test carried on by a committee appointed by the American Society of Heating and Ventilating Engineers with iron and steel pipe made by various companies, Prof. Thomson reported:

> "We believe this test demonstrates that modern steel pipe of good quality is at least as durable as modern strictly wrought iron, and is very much superior to a poor quality of wrought iron in this class of work." (A. S. H. & V. Engineers, 1909.)

> "Therefore, a rational deduction to draw from the preceding facts is that steel pipe is more durable than plain wrought iron pipe when used to convey hot water and subject only to internal corrosion. I know that the above summary is not in perfect harmony with the opinions of many engineers and contractors, but I can only record the facts as they are found to be without comment." "The Relative Corrosion of Wrought Iron and Soft Steel Pipes." —T. N. Thomson. (Proceedings American Society of Heating and Ventilating Engineers, Vol. XIV, 1908.)

This information supplements that on pages 12, 13, 106, 276-277

"This test checks up well with the aforesaid 1908 paper, and we believe demonstrates that modern steel pipe of good quality is at least as durable as modern strictly wrought iron pipe of good quality, and is very much superior to a poor quality of wrought iron in this class of work." (A. S. H. & V. Engineers, Vol. XV, 1909.)

"In closing we desire to call special attention to the fact that we find it is not safe to accept reports regarding the corrosion of wrought iron and steel pipes without first identifying the materials, because so many engineers cannot ordinarily distinguish the difference between them." "Report of Committee on Corrosion of Wrought Iron and Steel Pipes." (Proceedings American Society of Heating and Ventilating Engineers, Vol. XVI, 1910.)

Coal Mine Corrosion—"Corrosion tests in running mine water were carried on by Prof. Thomson, The Pittsburgh Coal Company, H. C. Frick Coal Company and others, these indicating that steel is at least equal to wrought iron in resisting corrosion." (Iron Age, July 12, 1906.)

The results of these tests of wrought iron and steel pipe in coal mines may be gleaned from the following extracts:

"The results indicate to us that steel is just as durable in the water in this mine as wrought iron."

Says one of the largest coal operators in Kentucky:

"We thought the data decidedly in favor of steel, in view of the fact that we had anticipated a reversal of the leaning. . . . The results of this investigation would appear to indicate no practical difference in the life to be obtained from either iron or steel piping in the hot water service."

This from a coal operator in Pennsylvania. Comparisons of new steel and iron pipes in the boiler feed and other lines led this large company, which made the test, to the exclusive use of "NATIONAL" Pipe.

"While corrosion was about the same, there was a pitting in the iron that we did not find in the steel, and the steel was corroded more uniformly. From the tests made, I know that the steel pipe is the better for such conditions."

This conclusion from an operator in the largest bituminous coal field in the world indicates the advantages gained by uniform material worked by the Spellerizing process in connection with "NATIONAL" Pipe.

Stoughton—In his text book, "The Metallurgy of Iron and Steel" (Hill Publishing Co., New York), Bradley Stoughton, one of those who has carried out exhaustive investigations, says:

"The evidence goes to show that properly made steel corrodes no more than wrought iron."

This information supplements that on pages 12, 13, 106, 275-277

In summing up a paper[1] on the corrosion of iron and steel, Bradley Stoughton, secretary of the American Institute of Mining Engineers, makes the following significant statement:

"No mention has been made here of the sometimes heated discussion that went on for several years in regard to the relative corrosion of wrought iron and steel, because it is my opinion, which I think is the same as that now held by many well informed authorities, that the difference between these classes of materials, if any, is very small, and is much less important than the effect of quality of manufacture. In other words, well-made steel, or well-made wrought iron, will resist rusting better than badly made material of its own or the other class, and the reason for this I have tried to point out in the preceding pages, at the same time endeavoring to show some of the precautions that it is possible for engineers, owners and builders to employ in order to secure less corrodible material for use in the erection of structures."

Howe and Stoughton—An investigation was made and the results arrived at were incorporated in a paper, "The Relative Corrosion of Steel and Wrought Iron Tubing"—H. M. Howe and Bradley Stoughton. (Proceedings of the American Society for Testing Materials. Vol. 8, 1908), read before the American Society for Testing Materials, which concluded with the following significant words:

"This is all the evidence which we have found and received permission to cite, though we have asked manufacturers prominently and financially interested in showing that steel is worse than iron, to give the addresses of those who could give us evidence. *None of that which we have found, but have not yet received permission to cite, is unfavorable to steel.*" (Page 250.)

(*See "NATIONAL" Bulletin No. 11.*)

Comparative tests of pipe steel carried on by these investigators using pipe made from steel in 1906 and 1897 have resulted in favor of the former. The skelp of 1897 showed a greater loss in weight by corrosion and decidedly deeper pitting in six months than the skelp of 1906 in thirteen months. In tests comparing steel skelp with wrought iron, it was found that the two materials lost practically the same weight by corrosion, yet the former had the advantage of a uniform corrosion since the—

"Wrought iron skelp pitted in seven months much deeper than the steel did in thirteen months." (Page 255.)

These investigators also state in regard to the durability of steel and iron wrought pipes in interlocking and signal systems that:

"We learn that twenty-nine pipes, all believed to be wrought iron, after long use in the interlocking and signal systems of a very

[1] "The Cause and Prevention of Corrosion of Iron and Steel."—The Engineering Magazine, July, 1911.

This information supplements that on pages 12, 13, 106, 275-277

important railroad, were lately examined, with the result that twelve were found to be steel and only seventeen iron. The life of the steel pipes was in this case longer than that of the iron ones. Thus, of those which were practically destroyed by corrosion and pitting—

11 were steel with an average life of 13.5 years.

8 were iron with an average life of 10.4 years.

Our information comes direct to us from the general superintendent of the railroad." (Page 250.)

Friend—J. Newton Friend, in his recent book, "The Corrosion of Iron and Steel" (Longmans Green Co., 1911), states:

"It would appear therefore that when everything is taken into consideration there is practically nothing to choose between wrought iron and steel as at present manufactured." (Page 286.) And finally concludes with these words: "These and many other instances might be cited as illustrating the fact that good steel corrodes at much the same rate as good wrought iron." (Page 288.)

Sang—A. Sang, in a thorough resume of the question entitled, "The Corrosion of Iron and Steel" (McGraw Hill Book Co., New York, 1910). says:

"Properly protected steel and iron rust to about the same extent, the steel doing so more uniformly," and adds, "The best quality of charcoal iron is practically as resistant as the best quality of steel used for similar purposes." (Page 49.)

In regard to pipe, Sang remarks:

"The carefully acquired experience of the largest manufacturers of tubes in the world, which induced them recently to abandon the manufacture of wrought iron pipe, teaches that the use of steel in place of iron, at least in the United States, for the special purpose of tubing is to be preferred; the tendency of steel to pit is somewhat less than that of iron and it welds at the joint fully as well." (Page 73.) (*See "NATIONAL" Bulletin No. 4.*)

"In the thirty complete service tests made by railroads during the years 1907 and 1908, modern steel tubing showed a slight superiority over so-called charcoal-iron tubing and the rusting was more uniform.

"Badly made steel will evidently corrode faster than a uniform product, and the question of the comparative corrosion of iron and steel should not be judged from the behavior of a poor quality; unfortunately, persons afflicted with mental hustling always generalize exceptions."

This information supplements that on pages 12, 18, 106, 275-277

Woolson—Prof. Ira H. Woolson (Engineering News, December 8, 1910) secured 89 samples of corroded pipe from seven bath houses in New York City. Seventeen of these samples proved to be wrought iron and the remainder steel. Prof. Woolson says:

> "In my judgment from the evidence collected there was absolutely no difference in the corrosion of the two classes of pipe; they appear to be equally susceptible to the attack."

This pipe was tested to destruction. (*See "NATIONAL" Bulletin No. 8.*)

Walker—Perhaps the most recent investigation reported is that of Dr. W. H. Walker (New England Water Works Association, March, 1912), of the Massachusetts Institute of Technology, who secured 64 samples of wrought iron and steel pipe in adjacent service. These samples had been in service from 2 to 17 years.

Dr. Walker reported that of the 64 samples secured 20 pairs favor steel, 18 iron, 9 show no difference in corrosion and 17 no corrosion at all. Dr. Walker says in this paper:

> "These results again demonstrate that taken on the average there is no difference in the corrosion of iron and steel pipe. Conversations held with engineers in charge of plants during this investigation confirm the statement already made that a pipe is frequently called steel when corrosion is found to be excessive, while it is set down as iron if it rusts but little." (*See "NATIONAL" Bulletin No. 10.*)

Ball—P. DeC. Ball (Cold Storage and Ice Trade Journal), in a paper read before the American Society of Refrigerating Engineers, stated as follows:

> "From thirty three years of personal observation, constructing, erecting and operating ice-making and refrigerating machines, absorption and compression types, and using iron pipes for the first fourteen years and iron and steel pipe for the next nineteen years, we are convinced that local conditions only govern the corrosion of pipes in refrigerating and ice-making machines, and that, chemically and mechanically, mild steel pipe meets the requirements of the refrigerating engineer in all respects, and better than any other pipe for the reason that it is superior in point of finish, strength, strength of seam, and uniformity of materials." (*See "NATIONAL" Bulletin No. 5.*)

Cosgrove—"Wrought Pipe Drainage Systems"[1] by J. J. Cosgrove contains many significant statements relative to the value of steel pipe when compared with wrought iron. We quote as follows:

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[1]Published by Standard Sanitary Mfg. Co., Pittsburgh, Pa.

This information supplements that on pages 12, 13, 106, 275-277

Page 3—"Such progress has been made toward improving the temper and weld of pipe steel, . . . that today wrought iron pipe can scarcely be distinguished from steel pipe, so far as the cutting, threading, and splitting are concerned." . . .

Page 7—"So far as wrought iron and steel pipes are concerned there is no appreciable difference between their length of life under similar conditions of exposure to corrosion, and one can be accepted as equally good as the other." . . .

Page 9—"As wrought iron and steel pipes are practically the same, they will be considered in this work, together with all other pipes of whatever metal or alloy which are put together with screw joints, as wrought pipes."

"Sanitary Refrigeration and Ice Making," published in 1914, another work by Mr. Cosgrove, contains the following extract (page 127) in regard to the durability and physical properties of steel and iron wrought pipe in refrigerating and ice-making systems:

"Wrought iron or steel pipe may be used in refrigeration work.

"So far as length of life is concerned, or deterioration from pitting, there is practically no difference between the two materials. When it comes to strength, however, the odds are in favor of steel pipe. This is true not only of the walls of the pipe, but of the seams as well, which is an important consideration.

"Steel pipe is more pliable than wrought iron pipe, and on account of this greater pliability, which permits steel pipe being bent and twisted without opening at the seam or otherwise failing, it makes a better material for refrigeration installation where numerous pipe bends are to be made. It might be well to note that in the bending of wrought pipe there is less liability of it failing at the seam if the pipe is held so the weld will be at the side, not at the top or bottom."

Woodworth—Mr. H. A. Woodworth, M. E., associated with the Merchant's Heat and Light Company, of Indianapolis, Ind., who read a paper "District Heating Distribution Systems" before the Annual Meeting of the National District Heating Association (1924) held in Rochester, N. Y., in regard to the merits of wrought iron and steel pipe, states that:

"The use of steel pipe is becoming more popular ever day, due to the good results found from practical experience. The author recently took up some 10-in. and 12-in. mains of steel pipe and laid 16-in. in their place, and was surprised to find that the removed pipe showed the original stamping of the manufacturers[1] after 13 years of usage on a hot-water heating system. . . . .

[1]Investigation revealed the fact that the pipe in question was "NATIONAL" Pipe, made by National Tube Company.

This information supplements that on pages 12, 13, 106, 275-277

The pipe was laid again on our steam lines, being insulated with sectional covering and tile, and we expect it to last twenty-five years longer." . . . .

"Since steel pipe is equally as good as wrought iron, it certainly is not a good policy to pay the difference in price for the latter pipe. Many other instances of steel pipe's good qualities might be cited but the discussion will no doubt bring out some mighty interesting features along this line."

Vincent—G. I. Vincent in a paper "Street Main Standards"[1] read before the Eighth Annual Convention of the American Gas Institute, October, 1913, presented a summary of standards, suggestions derived from the best practice, and recommendations from over 200 gas companies relative to the best materials for pipe manufactured for gas service. The following quotations from this paper indicate the majority expression in favor of mild steel pipe—"NATIONAL" Pipe:

"Steel or Wrought Iron— . . . The mild steel now being turned out by the tube mills is really the so-called wrought pipe, and an order for wrought pipe or black pipe will be filled with steel. The so-called genuine wrought iron pipe commands a premium of about 15 per cent over steel. *Its additional value is not apparent. Spellerized steel pipe is probably as durable as the wrought iron.*" . . .

"Sixty-four per cent of the companies specified steel pipe, thirty-six per cent specified wrought iron. As heretofore stated the advantages of wrought iron pipe as now rolled, over the mild steel pipe of the trade is not apparent. Wrought iron pipe of charcoal iron might be more durable than mild steel, but pipe is not manufactured of this material." . . .

SUMMARY

"This summary is prepared for convenience in reference. It gives each item and the suggested best practice. . . .

"STEEL MATERIAL FOR STREET MAINS—LOW PRESSURES

Steel vs. Wrought-Iron	Steel
Merchant or Full Weight	Full Weight
Size in Preference to Cast Iron	Less than 4" diameter
Life of Steel Mains Expected	No suggestion
Coating	None, except in bad soils

"STEEL MATERIAL—HIGH PRESSURE—PIPE LINES

Steel vs. Wrought-Iron	Steel
Weight	Line Pipe
Coating	None, except in bad soils"

[1]October, 1913, American Gas Institute News—Volume II, No. 7, pages 73-108.

This information supplements that on pages 12, 13, 106, 275-277

Shattuck—J. D. Shattuck in a paper "Welding of High Pressure Mains" read before the ninth annual meeting of the American Gas Institute (1914) in reporting the results of some tests on strength of autogenous welded pipe joints made on wrought iron and steel pipe by the Engineering Department of Swarthmore College states:

> "This test shows that steel pipe is stronger and more *ductile* than wrought iron pipe."

Duncan—R. B. Duncan associated with the United Gas Improvement Company of Philadelphia, Pa., in a paper "Installation and Maintenance of Service" read before the ninth annual meeting of the American Gas Institute (1914), states:

> "Succeeding the old lead pipe of the early days of the gas industry, wrought iron pipe was used almost exclusively for service work, for many years. It was far superior to lead from the standpoint of rigidity, being less liable to trap, and then it was cheaper. In the early '90's, the steel industry began making steel pipe cheaper than wrought iron and ever since that time, the use of wrought iron has been gradually falling off. The first impression of steel pipe gained by engineers was far from good; it had the reputation of being very uncertain as to temper and weld. Many claimed that great difficulty was experienced in cutting threads and that split pipe very frequently occurred. The general opinion of engineers that steel pipe was markedly inferior to wrought iron in resistance of corrosion is one that has caused much discussion.
>
> "Year by year the steel industry perfected their product until the pipe became as soft as wrought iron with no more power needed to thread same than wrought iron. As to the question of the corrosion of steel pipe versus wrought iron it is a feature that has been discussed by many prominent metallurgists of the country. The consensus of opinion seems to be that there is practically no difference between the two on this point. There have been many tests made both in laboratory and field. The United Gas Improvement Company have made many such tests. From laboratory experience, as far back as 1905, it was decided that there was little difference between wrought iron and steel in reference to corrosion; in fact, it was discovered that the new steel pipe appeared to have an outer coating of oxide which would resist corrosion far better than wrought iron. Many tests have been made of actual conditions in the field, and it has been the general opinion that both kinds of pipe showed almost the same loss of weight by corrosion, the tendency toward pitting being somewhat less in steel.
>
> "The steel industry has been developing a new process which, after several years' time, has given many encouraging results. By

This information supplements that on pages 12, 13, 106, 275-277

in this process the steel is treated mechanically and does not in any way depend upon skilled labor beyond keeping up the machinery involved, hence uniform treatment is assured.

"This new process is a method of treating metal which consists in subjecting the heated bloom to the action of rolls having regularly shaped projections on their working surfaces, then subjecting the bloom, while still hot, to the action of smooth faced rolls and repeating the action whereby the surface of the metal is worked so as to produce a uniform dense texture better adapted to resist corrosion, especially in the form of pitting.

"Summing up the comparison, I would say that the steel pipe had four points to its advantage, that would justify its use in preference to wrought iron, as follows:

(1) It costs much less.
(2) It is stronger and more ductile than wrought iron.
(3) It is more uniform in composition.
(4) The threads cut on steel pipe appear to be stronger."

The Gas Record[a] in publishing an abstract from Mr. Duncan's paper states, in regard to the value of the Spellerizing process which is applied to "NATIONAL" Pipe only (sizes four inches and under) that:

"The consensus of opinion is that modern steel pipe, particularly if Spellerized is as durable as wrought iron, and is, besides, cheaper, stronger, and more ductile and more uniform in composition."

Smith—The unbiased opinion of a recognized authority on any certain subject has a definite and ascertainable value. The following quotation is significant, being taken from a paper "Some Causes of Corrosion or Oxidation of Metals in a Refrigerating System" by Morgan B. Smith, published in Ice, October, 1913, issue relating to the merits of the Spellerizing process:

"Steel Pipe, which has been treated in such a manner as to eliminate or at least distribute evenly the mill scale may be joined with wrought iron or cast iron safely as a rule. . . . The same stock without the treatment for mill scale will show a decided tendency to corrode when joined with wrought iron or cast iron. The so-called Spellerized Steel fulfills this condition with respect to the scale."

[a]Page 222, September 23, 1914, Vol. 6, No. 6.

This information supplements that on pages 12, 13, 106, 875-877

Speller—F. N. Speller in summing up a series of articles on th relative durability of wrought iron and steel pipe under the headin "Plain Facts about 'NATIONAL' Pipe for the Plumber and Steamfitter published in the Plumber's Trade Journal, Dec. 15, 1913,[6] Jan. 1[7] and 1[8] and Feb. 1,[9] 1914, states that:

"It should be borne in mind by all thoughtful members of the trades handling pipe that:

"1. Steel pipe is no longer an experiment, but has a record of twenty-five years' service—and in that time has increased in use to ninety per cent of the entire production.

"2. Opinions should be based on a real personal knowledge, taking nothing for granted—the average user of pipe has abundant opportunity to investigate for himself.

"3. All the comparisons, which have been made in service covering the average life of pipe today, indicate clearly that there is no difference in life between iron and steel pipe as a class, although there is something to say between the various makes of each class.

"4. All reputable makes of pipe are now marked so that substitution or mistakes are no longer possible. The fact that so much steel pipe has been used, supposedly as wrought iron, in the past is very significant in the light of real experience.

"5. It is advisable to inquire carefully into the basis of statements made on the general question of iron and steel pipe—hearsay and supposition are dangerous substitutes for real experience in such matters."

Iron Trade Review—In a leading editorial The Iron Trade Review October 15, 1914, page 699, comments upon the tremendous growth of the steel pipe industry in the past decade and gives statistics showing tonnages of both wrought iron and steel pipe for years 1905 to 1913 inclusive as compiled by the Bureau of Statistics of the American Iron and Steel Institute, issued in a Special Statistical Bulletin No. 8, and in conclusion states:

"The popularity of steel pipe is due to a number of causes. Undoubtedly, its economy has been an influential factor, but the great increase in production during the past two decades cannot be attributed to price alone. Quality also has played an important part. The uniform character of well-made steel pipe is a factor in its favor, and its ductility adds to its serviceableness.

"As far as the subject of corrosion is concerned, without going into exhaustive arguments, it may be said that prominent metallurgists now agree that any special fears which may have been

[6] Pages 807-8.
[7] Pages 29-30.
[8] Pages 107-108.
[9] Pages 191-192.

This information supplements that on pages 12, 13, 106, 275-277

entertained regarding the resistance of steel pipe to corrosion are groundless. It seems, therefore, that there are sound economic reasons behind the tremendous increase in the production of steel pipe during the past twenty-five years."

Wilson—L. C. Wilson recently made a very careful and thorough investigation of all the data and information available regarding the relative durability of steel and iron wrought pipe in actual service compiled from many sources and representing the independent investigation of recognized authorities. In an article—"Wrought Iron or Steel Pipes?"—Mr. Wilson, after presenting the facts as contained in the evidence reviewed, concludes:

> "Viewing impartially all of the data presented so far, there seems to be little to choose between wrought iron and steel pipe on the whole, as regards their resistance to corrosive influences, but one point may be mentioned with reference to the manner in which these materials corrode: With steel the rusting takes place more or less uniformly over the surface, while wrought iron shows a decided inclination to form deep pits. That this is a dangerous tendency can hardly be doubted."

The technical editor of the Pittsburgh Gazette-Times, one of the leading newspapers in the iron and steel district, in reviewing Mr. Wilson's article states:

> "To paraphrase an old saying, a pipe wall is no stronger than its thinnest spot, therefore, to the extent in which wrought iron exhibits this defect (pitting) in greater measure than steel, it may be considered correspondingly inferior."

November 7, 1915.

Meier—In a paper[11] read before the local branch of the A. S. M. E. at Cornell University by Col. E. D. Meier, Past President of the American Society of Mechanical Engineers, entitled "Modern Boiler Problems," there is the following significant statement regarding the durability of steel and charcoal iron boiler tubes:

> "The United States Navy Department carried on a series of tests with various corrosive solutions at McKeesport, for a period of three months. The report of the Commission sums up that there was only a slight difference in corrosion between the (so called) 'charcoal' iron and the steel tubes, and that in favor of the latter."

Borden—A. W. Borden, chairman of the Committee on Distribution of the Iowa District Gas Association, in reporting the results of that

[11]Reprinted from the Sibley Journal of Engineering, June, 1912.

This information supplements that on pages 12, 18, 106, 275-277

committee's work at the annual meeting held May 26-28, 1915,[11] stated in regard to the merits of steel and iron wrought pipe that:

"There has been much discussion as to the relative merits of steel and wrought iron for main and service work. The latter material was formerly attributed with many advantages not accorded the steel pipe, but in recent years the improvement to this product had contributed very largely to dissipating the prejudices, which based upon real and fancied causes formerly existed, *until today it is claimed with conservatism that the best prepared steel pipe will surpass wrought iron in strength and ductility and has the added advantage of much lower cost.*"

Walter—Bruce Walter, Dry Blast Engineer, Isabella Furnace, Pittsburgh, Pa., during the discussion of Morgan B. Smith's paper—"Recent Developments in the Study of Corrosion in Concrete Buildings and Pipe Lines"—presented at the eleventh annual meeting of the American Society of Refrigerating Engineers, New York City, December 6-8, 1915, gave the results of his experience with steel and iron wrought pipes in refrigerating service. In 1905, shortly after the construction of a new air refrigerating plant, it was decided to reconstruct several of the ammonia condensers and install alternate lengths of steel and iron wrought pipe in an effort to determine the relative durability of steel and iron wrought pipe in this service. Recently, after ten years' service, it became necessary to renew certain parts of the apparatus. This afforded an opportunity to examine the pipe in the above referred condensers. Regarding the condition of the pipe in these condensers, Mr. Walter says:

"In short, there was clearly no difference in corrosion between the wrought iron and steel pipe after practically ten years' actual service conditions."

Stone—F. W. Stone, during the discussion of a paper—"Modern Wrought Gas Pipe"—read before the third annual meeting of the American Gas Institute, October 21-23, 1908, New York City, and published in the proceedings Vol. III, pages 462-474, stated that:

"Some two years ago, in order to satisfy myself which was best, I took some samples of wrought iron and of steel pipe and imbedded them in a cinder bed, and took them out occasionally to see how they were getting along. Up to the present time . . . . apparently there is little, if any, difference between the corrosion on the wrought iron and the corrosion on the steel pipe. If anything, the wrought iron is pitted a little deeper; that is, the pitting on the steel pipe is probably more general all over the surface, but the pitting on the wrought iron pipe is deeper on the spots that are affected." (Page 474.)

[11]Gas Record, June 9, 1915, page 428.

This information supplements that on pages 18, 18, 106, 276-277

"SHELBY" SEAMLESS STEEL TUBES

Page 15

Materials—A new grade of steel, called .12% Carbon Open-Hearth, is used for boiler tubes exclusively.

Chemical Analysis:

Carbon	.08 to .18 per cent.
Manganese	.30 to .50 per cent.
Phosphorus	not over .040 per cent.
Sulphur	not over .045 per cent.

Page 16

Physical Properties of "SHELBY" Seamless Steel Tubes

.17 Per Cent Carbon Steel.

Chemical Analysis:

The sulphur and phosphorus limits of .17% Carbon Steel should be changed to read as follows:

Sulphur	not over .045 per cent.
Phosphorus	not over .040 per cent.

Instead of

Sulphur	.025 to .040 per cent.
Phosphorus	.010 to .035 per cent.

This information supplements that on pages 15 and 16

Page 22 "NATIONAL" Standard Pipe—Black and Galvanized

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
17O.D.	17.000	16.214	.393	69.704	72.602	8	18.683	7⅛	90.941
18O.D.	18.000	17.182	.409	76.840	80.482	8	19.921	7⅛	108.672
20O.D.	20.000	19.182	.409	85.577	89.617	8	21.921	7⅛	120.187

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ¾-inch diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 feet, including the coupling.

All weights given in pounds. All dimensions in inches.

For general notes see page 21.

For test pressures see page 621. For illustration showing joint see page 77.

Page 23 "NATIONAL" Line Pipe

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
17O.D.	17.000	16.214	.393	69.704	72.769	8	18.683	7⅛	91.064
18O.D.	18.000	17.182	.409	76.840	80.659	8	19.921	7⅛	108.900
20O.D.	20.000	19.182	.409	85.577	89.794	8	21.921	7⅛	120.547

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ¾-inch diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 feet, including the coupling.

All weights given in pounds. All dimensions given in inches.

For general notes see page 21.

For test pressures see page 621. For illustration showing joint see page 77.

This information supplements that on pages 22 and 23

Page 29 "NATIONAL" California Diamond BX Casing

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Th'rds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
4½	4.750	4.082	.334	15.752	16.000	10	5.364	6⅝	9.963
4¾	5.000	4.500	.250	12.682	12.850	10	5.491	6⅝	8.533
4¾	5.000	4.408	.296	14.870	15.000	10	5.491	6⅝	8.533
6⅝	7.000	6.336	.332	23.643	24.000	10	7.698	7⅝	17.943
11	11.750	11.000	.375	45.557	47.000	10	12.866	8⅛	49.379
11	11.750	10.772	.489	58.811	60.000	10	12.866	8⅛	49.379
12½	13.000	12.220	.390	52.523	54.000	10	14.116	8⅛	54.508

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ¾-inch diameter per foot length for all sizes.

The weight per foot of casing with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths of small sizes will usually average less than 20 feet.

All weights given in pounds. All dimensions given in inches.

This casing not furnished in lighter weights, but can be made heavier than shown above.

When one size of casing is intended to telescope with another, it should always be specified when ordering.

On sizes made in more than one weight, weight desired must be specified.

For general notes see page 21. For test pressures see page 621.

For illustration showing joint see page 82.

Page 30 "NATIONAL" California Special External Upset Tubing

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
1¼	1.660	1.380	.140	2.272	2.300	11½	2.200	2⅞	1.049
2	2.375	2.041	.167	3.938	4.000	11½	3.060	3⅝	2.329
2	2.375	1.995	.190	4.433	4.500	11½	3.060	3⅝	2.329
2½	2.875	2.441	.217	6.160	6.250	11½	3.668	4⅛	3.891

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ¾-inch diameter per foot length for all sizes.

The weight per foot of tubing with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths will usually average less than 20 feet.

On sizes made in more than one weight, weight desired must be specified.

All weights given in pounds. All dimensions given in inches.

For general notes see page 21. For test pressures see page 623.

For illustration showing joint see page 82.

This information supplements that on pages 29 and 30

"NATIONAL" Special Rotary Pipe

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
*4	4.500	3.826	.337	14.083	15.000	8	5.393	6⅛	11.768
*4½	5.000	4.290	.355	17.611	18.000	8	5.803	6⅛	12.988
*5	5.563	4.813	.375	20.778	21.000	8	6.334	7⅛	16.561
*6	6.625	5.761	.432	28.573	29.000	8	7.396	7⅛	19.561

*These sizes are included in the list on page 34, but the coupling data has been revised.

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ¾-inch diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths of small sizes will usually average less than 20 feet.

All weights given in pounds. All dimensions given in inches.

On sizes made in more than one weight, weight desired must be specified.

For general notes see page 21. For test pressures see page 76. For illustration showing joint see page 79.

"NATIONAL" Special Upset Rotary Pipe

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
3	3.500	2.900	.300	10.252	10.486	8	4.248	6⅛	8.777
4½	5.000	4.388	.306	15.340	15.737	8	5.736	7⅛	15.787
6	6.625	5.937	.344	23.076	23.566	8	7.350	8⅛	22.904

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ¾-inch diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths of small sizes will usually average less than 20 feet.

All weights given in pounds. All dimensions given in inches.

On sizes made in more than one weight, weight desired must be specified.

For general notes see page 21. For test pressures see page 623. For illustration showing joint see page 79.

This information supplements that on page 34

Page 35 **"NATIONAL" South Penn Casing**

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
*5 3/16	5.500	4.892	.304	16.870	17.000	11½	6.155	5⅛	8.849
6¼	6.625	6.041	.292	19.750	20.000	11½	7.280	5⅝	11.647
6¼	6.625	5.913	.356	23.835	24.000	11½	7.280	5⅝	11.647
*6⅝	7.000	6.450	.275	19.751	20.000	10	7.699	6⅛	14.458
12½	13.000	12.356	.322	43.500	45.000	8	14.085	7⅛	46.464

*These sizes are included in the list on page 35 but the coupling data has been revised.

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ⅛-inch diameter per foot length for all sizes shown above, except the 12½-inch which is ¾-inch taper.

The weight per foot of casing with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths of small sizes will usually average less than 20 feet.

All weights given in pounds. All dimensions given in inches.

On sizes made in more than one weight, weight desired must be specified.

For general notes see page 21. For test pressures see page 621. For illustration showing joint see page 83.

Page 36 **"NATIONAL" Air Line Pipe**

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
*4	4.500	3.958	.271	12.240	12.500	8	5.500	4½	9.124

*This size is included in the list on page 36, but the weight and dimension data has been revised.

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

The above pipe is fitted with special air line couplings recessed for lead calking.

Taper of threads is ¾-inch diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths of small sizes will usually average less than 20 feet.

All weights given in pounds. All dimensions given in inches.

For general notes see page 21. For test pressures see page 623. For illustration showing joint see page 80.

This information supplements that on pages 35 and 36

Page 37

"NATIONAL" Dry Kiln Pipe

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
¾	1.050	.824	.113	1.130	1.140	14	1.367	2⅛	.374

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is ¾-inch diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths of small sizes will usually average less than 20 feet.

All weights given in pounds. All dimensions given in inches.

For general notes see page 21. For test pressure see page 623. For corrected illustration showing joint see page 624.

Page 37

"NATIONAL" Tuyere Pipe

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot plain ends
	External	Internal		
¾	1.050	.742	.154	1.473
1½	1.900	1.500	.200	3.631

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with plain ends and in random lengths unless otherwise ordered.

This pipe is made in random lengths up to 40 feet.

All weights given in pounds. All dimensions given in inches.

For general notes see page 21. For test pressures see page 623.

Page 40

"NATIONAL" Locomotive Boiler Tubes—Lap-Welded—Open-Hearth Steel

All Weights and Dimensions are Nominal

(For test pressures see page 622)

Diameters		Thickness		Weight per foot	Length of tube per square foot		Square foot of surface per lineal foot	
External	Internal	Inches	B.W.G.		External Surface	Internal Surface	External Surface	Internal Surface
2½	2.170	.165	8	4.114	1.527	1.760	.654	.568
2½	2.140	.180	7	4.460	1.527	1.784	.654	.560
3	2.670	.165	8	4.995	1.273	1.430	.785	.699
3	2.640	.180	7	5.421	1.273	1.446	.785	.691

NOTE.—Please eliminate from page 40 all reference to 2½-inch O. D. No. 13 gauge, and 3-inch O. D. No. 13 gauge Lap-Welded "NATIONAL" Locomotive Boiler Tubes.

This information supplements that on pages 37 and 40

"NATIONAL" Ammonia Pipe, Specially Recommended for Ammonia Purposes

All Weights and Dimensions are Nominal

Size	Diameters		Thickness	Weight per foot		Thr'ds per inch	Couplings		
	External	Internal		Plain ends	Threads and couplings		Diameter	L'gth	Weight
3/4	1.050	.824	.113	1.130	1.137	14	1.300	2 1/8	.323
1	1.315	1.049	.133	1.678	1.686	11 1/2	1.559	2 3/8	.454
1 1/4	1.660	1.380	.140	2.272	2.297	11 1/2	2.031	2 7/8	.992
1 1/2	1.900	1.610	.145	2.717	2.744	11 1/2	2.271	2 7/8	1.125
2	2.375	2.067	.154	3.652	3.706	11 1/2	2.817	3 5/8	2.098

Sizes 3/4-inch to 1 1/2-inch, inclusive, are butt-welded and redrawn from a larger size; 2-inch size is lap-welded (not redrawn.)

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is 3/4-inch diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 feet, including the coupling, but shipping lengths of small sizes will usually average less than 20 feet.

All weights given in pounds. All dimensions given in inches.

For general notes see page 21. For test pressures see page 623. For illustration showing joint see page 624.

"NATIONAL" Hydraulic Pipe

All Weights and Dimensions are Nominal

Size	External Diameter	THICKNESS .625		.750		.875		1.000	
		Weight per foot plain ends	Test pressure in lbs.	Weight per foot plain ends	Test pressure in lbs.	Weight per foot plain ends	Test pressure in lbs.	Weight per foot plain ends	Test pressure in lbs.
9	9.625	60.075	1600	71.089	1700	81.769	1800	92.116	1800
10	10.750	67.585	1400	80.101	1500	92.283	1600	104.131	1800
11	11.750	74.260	1300	88.111	1400	101.628	1500	114.811	1600
12	12.750	80.935	1200	96.121	1300	110.973	1400	125.491	1500

The permissible variation in weight is 10 per cent above and 10 per cent below.

Furnished with plain ends and in random lengths, unless otherwise ordered.

All weights given in pounds. All dimensions given in inches.

For general notes see page 21.

"NATIONAL" Large O. D. Pipe, Plain Ends

All Weights and Dimensions are Nominal

External Diameter		THICKNESS											
		1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8
14	Weight per foot plain ends....	36.713	45.682	54.568	63.371	72.091	80.726	89.279	97.748	106.134	122.654	138.842	154.695
	Test pressure in pounds.......	500	650	750	900	1000	1150	1250	1275	1300	1400	1500	1600
15	Weight per foot plain ends....	39.383	49.020	58.573	68.044	77.431	86.734	95.054	105.091	114.144	132.000	149.522	166.710
	Test pressure in pounds.......	500	600	700	800	950	1100	1200	1250	1300	1400	1500	1600
16	Weight per foot plain ends....	42.053	52.357	62.579	72.716	82.771	92.742	102.629	112.433	122.154	141.345	160.202	178.725
	Test pressure in pounds.......	450	550	700	800	950	1100	1200	1250	1300	1400	1500	1600
17	Weight per foot plain ends....	44.723	55.695	66.584	77.389	88.111	98.749	109.304	119.776	130.164	150.690	170.882	190.740
	Test pressure in pounds.......	400	500	650	750	850	950	1100	1200	1300	1400	1500	1600
18	Weight per foot plain ends....	47.393	59.032	70.589	82.061	93.451	104.757	115.979	127.118	138.174	160.035	181.562	202.756
	Test pressure in pounds.......	400	500	600	700	800	950	1050	1150	1250	1400	1500	1600
20	Weight per foot plain ends....	....	65.708	78.599	91.407	104.131	116.772	129.330	141.804	154.194	178.725	202.923	226.786
	Test pressure in pounds.......	....	450	500	650	750	800	950	1000	1100	1350	1500	1600
21	Weight per foot plain ends....	....	69.045	82.604	96.079	109.471	122.780	136.005	149.146	162.204	....	....	....
	Test pressure in pounds.......	....	450	500	600	700	800	900	950	1000	....	....	....

This information supplements that on pages 22 to 45, 68 to 76

"NATIONAL" Large O. D. Pipe, Plain Ends
(Concluded)

External Diameter		THICKNESS											
		1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8
22	Weight per foot plain ends....	....	72.383	86.609	100.752	114.811	128.787	142.680	156.489	170.215	....	....	....
	Test pressure in pounds.......	....	450	500	600	650	750	850	900	1000	....	....	....
24	Weight per foot plain ends....	....	....	94.619	110.097	125.491	140.802	156.030	171.174	186.235	....	....	....
	Test pressure in pounds.......	....	....	500	550	600	700	800	850	900	....	....	....
26	Weight per foot plain ends....	....	....	102.629	119.442	136.172	152.818	169.380	185.859	202.255	....	....	....
	Test pressure in pounds.......	....	....	450	500	550	650	700	750	800	....	....	....
28	Weight per foot plain ends....	....	....	....	128.787	146.852	164.833	182.730	200.545	218.275	....	....	....
	Test pressure in pounds.......	....	....	....	450	500	600	650	700	800	....	....	....
30	Weight per foot plain ends....	....	....	....	138.132	157.532	176.848	196.081	215.230	234.296	....	....	....
	Test pressure in pounds.......	....	....	....	450	450	550	600	625	650	....	....	....

The permissible variation in weight is 10 per cent above and 10 per cent below.
Furnished with plain ends and in random lengths unless otherwise ordered.
All weights given in pounds. All dimensions given in inches.
For general notes see page 21.

This information supplements that on pages [illegible] to 45, 68 to [illegible]

"NATIONAL" Plain End Pipe for Gas Lines

Ends Fitted Specially for Specified Coupler or for Welding

All Weights and Dimensions are Nominal

The permissible variation in weight is 5 per cent above and 5 per cent below

O. D. inches	Nominal thickness			Mill test	Weight per foot
	Birming'm wire gauge	Fraction inches	Decimal inches		
4½	..	..	.128	700	5.976
4½	10	..	.134	700	6.248
4½	..	..	.142	800	6.609
4½	9	..	.148	800	6.879
4½	8	..	.165	900	7.630
4½	7	..	.180	1100	8.304
4½	..	3/16	.1875	1200	8.635
4½	6	..	.203	1300	9.316
4½	..	..	.205	1300	9.403
4½	..	..	.237	1600	10.790
4½	..	¼	.250	1800	11.347
4½	..	..	.252	1800	11.433
4½	..	..	.255	1800	11.561
4½	..	..	.271	1800	12.240
4½	..	5/16	.3125	1900	13.975
4½	..	..	.337	2000	14.983
4¾	..	..	.145	800	7.131
4¾	..	3/16	.1875	1100	9.136
4¾	..	..	.193	1200	9.393
4¾	..	¼	.250	1600	12.015
4¾	..	5/16	.3125	1800	14.810
4¾	..	..	.334	1800	15.752
5	10	..	.134	700	6.963
5	9	..	.148	750	7.669
5	..	..	.152	800	7.870
5	8	..	.165	900	8.520
5	7	..	.180	1000	9.266
5	..	3/16	.1875	1100	9.637
5	6	..	.203	1200	10.400
5	5	..	.220	1400	11.231
5	..	..	.247	1600	12.538
5	..	¼	.250	1600	12.682
5	..	..	.288	1700	14.493
5	..	..	.306	1700	15.340
5	..	5/16	.3125	1700	15.644
5	..	..	.355	1800	17.611
5¼	..	..	.153	800	8.328
5¼	..	..	.182	900	9.851
5¼	..	3/16	.1875	1000	10.137
5¼	..	..	.241	1400	12.892
5¼	..	¼	.250	1500	13.350
5¼	..	..	.301	1600	15.909
5¼	..	5/16	.3125	1600	16.479
5½	10	..	.134	700	7.679
5½	..	..	.154	800	8.792
5½	..	3/16	.1875	1000	10.638
5½	..	..	.228	1200	12.837

is information supplements that on pages 22 to 45, 68 to 76

"NATIONAL" Plain End Pipe for Gas Lines
(Continued)

Ends Fitted Specially for Specified Coupler or for Welding

O. D. inches	Nominal thickness: Birming'm wire gauge	Nominal thickness: Fraction inches	Nominal thickness: Decimal inches	Mill test	Weight per foot
5½	..	¼	.250	1400	14.017
5½	..	..	.304	1600	16.870
5½	..	5/16	.3125	1600	17.313
5 9/16	..	3/16	.1875	1000	10.764
5 9/16	..	¼	.250	1400	14.185
5 9/16	..	..	.258	1500	14.617
5 9/16	..	..	.293	1600	16.491
5 9/16	..	..	.304	1600	17 074
5 9/16	..	5/16	.3125	1600	17.523
5 9/16	..	⅜	.375	1800	20.778
6	..	..	.140	700	8.762
6	9	..	.148	700	9.250
6	..	5/32	.15625	800	9.751
6	..	..	.164	800	10.222
6	8	..	.165	800	10.282
6	7	..	.180	900	11.188
6	..	3/16	.1875	900	11.639
6	..	..	.190	900	11.789
6	6	..	.203	1000	12.568
6	..	7/32	.21875	1100	13.506
6	5	..	.220	1100	13.580
6	..	..	.224	1100	13.818
6	4	..	.238	1200	14.646
6	..	¼	.250	1300	15.352
6	3	..	.259	1400	15.880
6	..	..	.275	1500	16.814
6	..	..	.324	1600	19.641
6⅝	..	..	.169	800	11.652
6⅝	7	..	.180	800	12.390
6⅝	..	..	.184	800	12.657
6⅝	..	..	.185	800	12.724
6⅝	..	3/16	.1875	800	12,891
6⅝	6	..	.203	900	13.923
6⅝	..	7/32	.21875	1000	14.966
6⅝	5	..	.220	1000	15.049
6⅝	4	..	.238	1100	16 234
6⅝	..	..	.245	1100	16.694
6⅝	..	¼	.250	1100	17.021
6⅝	3	..	.259	1200	17.609
6⅝	..	..	.280	1500	18.974
6⅝	..	9/32	.28125	1500	19.055
6⅝	2	..	.284	1500	19.233
6⅝	..	..	.288	1500	19.491
6⅝	..	..	.292	1500	19.750
6⅝	1	..	.300	1500	20.265
6⅝	..	5/16	.3125	1500	21.068
6⅝	0	..	.340	1600	22.822
6⅝	..	..	.344	1600	23.076
6⅝	..	..	.352	1600	23.582
6⅝	..	..	.356	1600	23.835
6⅝	..	..	.385	1600	25.658

'his information supplements that on pages 22 to 45, 68 to 7[illegible]

"NATIONAL" Plain End Pipe for Gas Lines
(Continued)

Ends Fitted Specially for Specified Coupler or for Welding

O. D. inches	Nominal thickness			Mill test	Weight per foot
	Birming'm wire gauge	Fraction inches	Decimal inches		
6⅝	..	..	.417	1700	27.648
6⅝	..	..	.432	1800	28.573
7	..	..	.149	600	10.902
7	..	5/32	.15625	700	11.420
7	8	..	.165	700	12.044
7	..	..	.174	800	12.685
7	7	..	.180	800	13.110
7	..	3/16	.1875	800	13.642
7	6	..	.203	900	14.736
7	..	7/32	.21875	1000	15.842
7	5	..	.220	1000	15.930
7	..	..	.231	1000	16.699
7	4	..	.238	1000	17.188
7	..	¼	.250	1100	18.022
7	3	..	.259	1100	18.646
7	..	..	.272	1200	19.544
7	..	..	.275	1200	19.751
7	..	9/32	.28125	1200	20.181
7	2	..	.284	1200	20.370
7	1	..	.300	1300	21.467
7	..	5/16	.3125	1300	22.319
7	..	..	.333	1300	23.711
7	..	..	.362	1400	25.663
7	..	..	.393	1500	27.731
7	..	..	.423	1600	29.712
7⅝	..	..	.181	750	14.390
7⅝	..	3/16	.1875	750	14.893
7⅝	6	..	.203	800	16.091
7⅝	..	7/32	.21875	900	17.303
7⅝	5	..	.220	900	17.399
7⅝	4	..	.238	1000	18.776
7⅝	..	¼	.250	1000	19.691
7⅝	3	..	.259	1000	20.375
7⅝	..	9/32	.28125	1100	22.059
7⅝	2	..	.284	1100	22.266
7⅝	..	..	.301	1200	23.544
8	..	..	.158	600	13.233
8	8	..	.165	600	13.807
8	7	..	.180	700	15.033
8	..	..	.185	700	15.441
8	..	..	.186	700	15.522
8	..	3/16	.1875	700	15.644
8	6	..	.203	800	16.904
8	..	7/32	.21875	800	18.179
8	5	..	.220	800	18.280
8	..	..	.236	900	19.569
8	4	..	.238	900	19.730
8	..	¼	.250	1000	20.692
8	3	..	.259	1000	21.412
8	..	9/32	.28125	1100	23.185
8	2	..	.284	1100	23.403

is information supplements that on pages 22 to 45, 68 to 76

"NATIONAL" Plain End Pipe for Gas Lines
(Continued)
Ends Fitted Specially for Specified Coupler or for Welding

O. D. inches	Nominal thickness Birming'm wire gauge	Fraction inches	Decimal inches	Mill test	Weight per foot
8	1	..	.300	1200	24.671
8	..	..	.307	1200	25.223
8	..	5/16	.3125	1200	25.657
8 5/8	..	..	.188	750	16.940
8 5/8	6	..	.203	750	18.259
8 5/8	..	..	.217	800	19.486
8 5/8	..	7/32	.21875	800	19.639
8 5/8	5	..	.220	800	19.748
8 5/8	4	..	.238	900	21.318
8 5/8	..	1/4	.250	900	22.361
8 5/8	3	..	.259	900	23.141
8 5/8	..	..	.264	1000	23.574
8 5/8	..	..	.277	1000	24.696
8 5/8	..	9/32	.28125	1000	25.062
8 5/8	2	..	.284	1000	25.299
8 5/8	1	..	.300	1100	26.673
8 5/8	..	..	.304	1100	27.016
8 5/8	..	..	.311	1200	27.615
8 5/8	..	5/16	.3125	1200	27.743
8 5/8	..	..	.322	1200	28.554
8 5/8	0	..	.340	1200	30.084
8 5/8	..	11/32	.34375	1200	30.402
8 5/8	..	..	.352	1200	31.101
8 5/8	..	..	.354	1200	31.270
8 5/8	..	3/8	.375	1300	33.041
8 5/8	..	..	.400	1300	35.137
8 5/8	..	13/32	.40625	1300	35.659
8 5/8	000	..	.425	1400	37.220
8 5/8	..	7/16	.4375	1400	38.256
8 5/8	..	..	.487	1500	42.327
9	..	..	.167	600	15.754
9	7	..	.180	600	16.955
9	..	3/16	.1875	600	17.647
9	..	..	.196	600	18.429
9	6	..	.203	700	19.072
9	..	7/32	.21875	750	20.515
9	5	..	.220	750	20.629
9	4	..	.238	800	22.271
9	..	1/4	.250	800	23.362
9	3	..	.259	800	24.179
9	..	9/32	.28125	900	26.189
9	2	..	.284	900	26.437
9	1	..	.300	1000	27.875
9 5/8	7	..	.180	600	18.157
9 5/8	..	3/16	.1875	600	18.898
9 5/8	6	..	.203	600	20.427
9 5/8	..	7/32	.21875	700	21.975
9 5/8	5	..	.220	700	22.098
9 5/8	4	..	.238	800	23.860
9 5/8	..	1/4	.250	800	25.031
9 5/8	3	..	.259	800	25.907

This information supplements that on pages 22 to 45, 68 to 76

"NATIONAL" Plain End Pipe for Gas Lines
(Continued)
Ends Fitted Specially for Specified Coupler or for Welding

O. D. inches	Nominal thickness			Mill test	Weight per foot
	Birming'm wire gauge	Fraction inches	Decimal inches		
9⅝	..	9/32	.28125	900	28.066
9⅝	2	..	.284	900	28.332
9⅝	1	..	.300	1000	29.877
9⅝	..	5/16	.3125	1000	31.080
9⅝	0	..	.340	1200	33.716
9⅝	..	..	.342	1200	33.907
10	..	..	.175	500	18.363
10	7	..	.180	500	18.878
10	..	3/16	.1875	600	19.649
10	6	..	.203	600	21.240
10	..	..	.208	600	21.752
10	..	..	.209	600	21.855
10	..	7/32	.21875	600	22.851
10	5	..	.220	600	22.979
10	4	..	.238	700	24.813
10	..	¼	.250	700	26.032
10	3	..	.259	800	26.945
10	..	..	.270	800	28.057
10	..	9/32	.28125	900	29.193
10	..	..	.283	900	29.369
10	2	..	.284	900	29.470
10	1	..	.300	900	31.079
10	..	..	.308	1000	31.881
10	..	5/16	.3125	1000	32.332
10	0	..	.340	1100	35.077
10¾	6	..	.203	600	22.866
10¾	..	7/32	.21875	600	24.604
10¾	5	..	.220	600	24.741
10¾	4	..	.238	700	26.720
10¾	..	¼	.250	700	28.035
10¾	3	..	.259	700	29.019
10¾	..	..	.279	800	31.201
10¾	..	9/32	.28125	800	31.445
10¾	2	..	.284	800	31.745
10¾	1	..	.300	900	33.482
10¾	..	..	.302	900	33.699
10¾	..	..	.307	900	34.240
10¾	..	..	.348	1000	38.661
10¾	..	..	.365	1000	40.483
10¾	..	..	.395	1000	43.684
10¾	..	..	.424	1100	46.760
10¾	..	..	.483	1200	52.962
10¾	..	½	.500	1200	54.735
11	..	..	.185	500	21.368
11	6	..	.203	500	23.408
11	..	7/32	.21875	600	25.188
11	5	..	.220	600	25.329
11	..	..	.224	600	25.780
11	4	..	.238	700	27.355
11	..	¼	.250	700	28.702
11	3	..	.259	700	29.711

"NATIONAL" Plain End Pipe for Gas Lines
(Continued)

Ends Fitted Specially for Specified Coupler or for Welding

O. D. inches	Nominal thickness			Mill test	Weight per foot
	Birming'm wire gauge	Fraction inches	Decimal inches		
11	..	9/32	.28125	800	32.196
11	2	..	.284	800	32.503
11	..	..	.290	800	33.171
11	1	..	.300	800	34.283
11	..	5/16	.3125	900	35.670
11	0	..	.340	900	38.709
11¾	6	..	.203	500	25.034
11¾	..	7/32	.21875	600	26.940
11¾	5	..	.220	600	27.091
11¾	4	..	.238	600	29.262
11¾	..	¼	.250	600	30.705
11¾	3	..	.259	600	31.785
11¾	..	9/32	.28125	700	34.449
11¾	2	..	.284	700	34.778
11¾	1	..	.300	800	36.686
11¾	..	5/16	.3125	800	38.173
11¾	0	..	.340	900	41.432
11¾	..	11/32	.34375	900	41.875
11¾	..	⅜	.375	900	45.557
12	..	..	.194	500	24.461
12	6	..	.203	500	25.576
12	..	7/32	.21875	500	27.524
12	5	..	.220	500	27.678
12	..	..	.229	600	28.788
12	4	..	.238	600	29.897
12	..	..	.243	600	30.512
12	..	..	.244	600	30.635
12	..	..	.2485	600	31.188
12	..	¼	.250	600	31.372
12	3	..	.259	600	32.477
12	..	..	.2715	700	34.008
12	..	9/32	.28125	700	35.200
12	2	..	.284	700	35.536
12	..	..	.292	700	36.512
12	1	..	.300	700	37.487
12	..	..	.308	800	38.460
12	..	..	.310	800	38.703
12	..	5/16	.3125	800	39.007
12	..	..	.320	800	39.918
12	0	..	.340	900	42.340
12	..	11/32	.34375	900	42.793
12	..	⅜	.375	900	46.558
12¾	6	..	.203	500	27.202
12¾	..	7/32	.21875	500	29.276
12¾	5	..	.220	500	29.440
12¾	4	..	.238	500	31.803
12¾	..	¼	.250	600	33.375
12¾	3	..	.259	600	34.552
12¾	..	9/32	.28125	700	37.453
12¾	2	..	.284	700	37.811
12¾	1	..	.300	700	39.890

"NATIONAL" Plain End Pipe for Gas Lines
(Continued)
Ends Fitted Specially for Specified Coupler or for Welding

O. D. inches	Nominal thickness			Mill test	Weight per foot
	Birming'm wire gauge	Fraction inches	Decimal inches		
12¾	..	5/16	.3125	700	41.510
12¾	..	..	.330	800	43.773
12¾	0	..	.340	800	45.063
12¾	..	11/32	.34375	800	45.547
12¾	..	⅜	.375	900	49.562
13	..	..	.202	500	27.610
13	6	..	.203	500	27.744
13	..	7/32	.21875	500	29.860
13	5	..	.220	500	30.028
13	4	..	.238	500	32.439
13	..	..	.247	600	33.642
13	..	¼	.250	600	34.043
13	3	..	.259	600	35.243
13	..	..	.281	700	38.171
13	..	9/32	.28125	700	38.204
13	2	..	.284	700	38.569
13	1	..	.300	700	40.691
13	..	..	.310	700	42.014
13	..	5/16	.3125	700	42.345
13	..	..	.320	800	43.335
13	0	..	.340	800	45.971
13	..	11/32	.34375	800	46.464
13	..	..	.359	900	48.467
13	..	..	.361	900	48.730
13	..	..	.390	1000	52.523
14	..	..	.210	500	30.928
14	..	7/32	.21875	500	32.196
14	5	..	.220	500	32.377
14	4	..	.238	500	34.981
14	..	..	.248	550	36.424
14	..	¼	.250	550	36.713
14	3	..	.259	550	38.009
14	..	..	.276	600	40.454
14	..	9/32	.28125	600	41.208
14	2	..	.284	600	41.602
14	1	..	.300	600	43.895
14	..	..	.310	700	45.325
14	..	5/16	.3125	700	45.682
14	..	..	.328	750	47.894
14	0	..	.340	750	49.602
14	..	11/32	.34375	750	50.136
14	..	⅜	.375	750	54.568
14	..	13/32	.40625	800	58.980
14	..	7/16	.4375	900	63.371
14	..	15/32	.46875	1000	67.741
15	..	..	.222	500	35.038
15	4	..	.238	500	37.523
15	..	¼	.250	500	39.383
15	3	..	.259	550	40.775
15	..	..	.260	550	40.930
15	..	9/32	.28125	550	44.212

This information supplements that on pages 22 to 45, 68 to 76

"NATIONAL" Plain End Pipe for Gas Lines
(Continued)
Ends Fitted Specially for Specified Coupler or for Welding

O. D. inches	Nominal thickness			Mill test	Weight per foot
	Birming'm wire gauge	Fraction inches	Decimal inches		
15	2	..	.284	550	44.636
15	..	..	.291	550	45.714
15	1	..	.300	600	47.099
15	..	5/16	.3125	600	49.020
15	..	..	.320	650	50.171
15	0	..	.340	700	53.234
15	..	11/32	.34375	700	53.807
15	..	3/8	.375	750	58.573
15	..	13/32	.40625	800	63.319
15	..	7/16	.4375	800	68.044
15	..	15/32	.46875	900	72.748
15	..	1/2	.500	1000	77.431
15	..	9/16	.5625	1100	86.734
16	..	..	.234	500	39.401
16	4	..	.238	500	40.065
16	..	1/4	.250	500	42.053
16	3	..	.259	500	43.542
16	..	..	.270	550	45.359
16	..	9/32	.28125	550	47.215
16	2	..	.284	550	47.669
16	1	..	.300	550	50.303
16	..	..	.302	550	50.632
16	..	5/16	.3125	550	52.357
16	..	..	.330	600	55.228
16	0	..	.340	650	56.865
16	..	11/32	.34375	650	57.478
16	..	3/8	.375	750	62.579
16	..	..	.401	800	66.806
16	..	13/32	.40625	800	67.658
16	..	7/16	.4375	800	72.716
16	..	15/32	.46875	900	77.754
16	..	1/2	.500	1000	82.771
17	..	..	.240	450	42.959
17	..	1/4	.250	450	44.723
17	3	..	.259	450	46.308
17	..	9/32	.28125	500	50.219
17	2	..	.284	500	50.702
17	1	..	.300	500	53.507
17	..	5/16	.3125	500	55.695
17	0	..	.340	600	60.496
17	..	11/32	.34375	600	61.150
17	..	3/8	.375	650	66.584
17	..	..	.393	750	69.704
17	..	13/32	.40625	750	71.997
17	..	7/16	.4375	750	77.389
17	..	15/32	.46875	800	82.760
17	..	1/2	.500	900	88.111
17	..	9/16	.5625	1000	98.749
18	..	..	.245	450	46.458
18	..	1/4	.250	450	47.393
18	3	..	.259	450	49.074
18	..	9/32	.28125	500	53.223

This information supplements that on pages 22 to 45, 68 to 7

"NATIONAL" Plain End Pipe for Gas Lines
(Concluded)
Ends Fitted Specially for Specified Coupler or for Welding

O. D. inches	Nominal thickness: Birming'm wire gauge	Fraction inches	Decimal inches	Mill test	Weight per foot
18	2	..	.284	500	53.735
18	1	..	.300	500	56.711
18	..	..	.310	500	58.568
18	..	5/16	.3125	500	59.032
18	0	..	.340	550	64.127
18	..	11/32	.34375	550	64.821
18	..	3/8	.375	600	70.589
18	..	13/32	.40625	700	76.336
18	..	..	.409	700	76.840
18	..	7/16	.4375	700	82.061
18	..	15/32	.46875	750	87.767
18	..	1/2	.500	800	93.451
18	..	9/16	.5625	900	104.757
19	3	..	.259	450	51.840
19	..	9/32	.28125	450	56.227
19	2	..	.284	450	56.768
19	1	..	.300	500	59.915
19	..	5/16	.3125	500	62.370
19	0	..	.340	550	67.759
19	..	11/32	.34375	550	68.492
19	..	3/8	.375	600	74.594
19	..	13/32	.40625	650	80.674
19	..	7/16	.4375	700	86.734
19	..	15/32	.46875	750	92.773
19	..	1/2	.500	800	98.791
20	..	..	.272	450	57.309
20	..	9/32	.28125	450	59.231
20	2	..	.284	450	59.801
20	1	..	.300	450	63.119
20	..	5/16	.3125	500	65.708
20	0	..	.340	550	71.390
20	..	11/32	.34375	550	72.164
20	..	3/8	.375	600	78.599
20	..	..	.409	650	85.577
22	..	..	.301	450	69.756
22	..	5/16	.3125	450	72.383
22	0	..	.340	500	78.652
22	..	11/32	.34375	500	79.506
22	..	3/8	.375	500	86.609
22	..	..	.400	550	92.276
22	..	13/32	.40625	550	93.691
22	..	7/16	.4375	600	100.752
22	..	15/32	.46875	600	107.792
22	..	1/2	.500	650	114.811
24	..	..	.330	450	83.423
24	0	..	.340	450	85.915
24	..	11/32	.34375	450	86.849
24	..	3/8	.375	500	94.619
24	..	13/32	.40625	500	102.368
24	..	7/16	.4375	550	110.097
24	..	15/32	.46875	550	117.805
24	..	1/2	.500	600	125.491

This information supplements that on pages 22 to 45, 68 to 76

SQUARE AND RECTANGULAR PIPE

Since the publication of the 1913 edition of Book of Standards, National Tube Company has discontinued the manufacture of welded square and rectangular pipe. Orders can be filled, however, with "SHELBY" Seamless Square and Rectangular Tubing, which will be found to surpass the welded pipe in finish, strength, accuracy to size, etc.

This information cancels that on pages 45, 66, 67, 85 to 88

PROPERTIES OF PIPE

Definition of Strength Factor "Q."

$$Q = 2.25 \frac{I}{y}$$

Strength Factor "Q" represents the strength of the pipe to resist bending action, and is the resisting moment in thousands of foot pounds, the stress in the material being 27,000 pounds per square inch. For any other allowable stress in the material the resisting moment is directly proportional.

…is information supplements that on pages 58 to 65

Properties of Pipe

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2}\,\frac{I}{\text{O. D.}}$$

y = distance of farthest fiber from axis.

External diameter O. D.	Thickness	Weight per foot	Moment of inertia I	Section modulus I/y	Area of metal, square inches A	Radius of gyration squared $R^2 = I/A$	Radius of gyration R	Strength factor Q
2.500	.165	4.114	.8290	.6632	1.210	.6849	.8276	1.492
2.500	.180	4.460	.8880	.7104	1.312	.6769	.8227	1.598
2.875	.366	9.807	2.318	1 613	2.885	.8036	.8965	3.629
3.000	.180	5.421	1.592	1.061	1.595	.9981	.9990	2.387
4.500	.128	5.976	4.204	1.869	1.758	2.391	1.546	4.204
4.500	.148	6.879	4.796	2.132	2.023	2.370	1.540	4.796
4.500	.165	7.639	5.286	2.349	2.247	2.352	1.534	5.286
4.500	.180	8.304	5.709	2.537	2.443	2.337	1.529	5.709
4.500	.1875	8.635	5.917	2.630	2.540	2.329	1.526	5.917
4.500	.203	9.316	6.339	2.817	2.740	2.313	1.521	6.339
4.500	.3125	13.975	9.061	4.027	4.111	2.204	1.485	9.061
4.750	.1875	9.136	7.005	2.949	2.688	2.606	1.614	6.636
4.750	.250	12.015	8.974	3.778	3.534	2.539	1.593	8.501
4.750	.3125	14.810	10.78	4.537	4.357	2.474	1.573	10.21
5.000	.165	8.520	7.332	2.933	2.506	2.926	1.710	6.599
5.000	.180	9.266	7.926	3.171	2.726	2.908	1.705	7.134
5.000	.1875	9.637	8.219	3.288	2.835	2.899	1.703	7.397
5.000	.203	10.400	8.815	3.526	3.059	2.882	1.698	7.934
5.000	.220	11.231	9.456	3.782	3.304	2.862	1.692	8.510
5.000	.296	14.870	12.15	4.859	4.374	2.777	1.666	10.93
5.000	.3125	15.644	12.70	5.078	4.602	2.759	1.661	11.43
5.250	.1875	10.137	9.566	3.644	2.982	3.208	1.791	8.200
5.250	.250	13.350	12.30	4.687	3.927	3.133	1.770	10.55
5.250	.3125	16.479	14.83	5.650	4.847	3.060	1.749	12.71
5.500	.134	7.679	8.136	2.958	2.259	3.601	1.898	6.656
5.500	.1875	10.638	11.05	4.019	3.129	3.532	1.879	9.044
5.500	.250	14.017	14.24	5.178	4.123	3.453	1.858	11.65
5.500	.3125	17.313	17.19	6.252	5.093	3.376	1.837	14.07
5.563	.1875	10.764	11.45	4.117	3.166	3.616	1.902	9.263
5.563	.250	14.185	14.76	5.305	4.173	3.536	1.881	11.94
5.563	.294	16.544	16.94	6.091	4.867	3.481	1.866	13.70
5.563	.3125	17.523	17.83	6.409	5.155	3.458	1.860	14.42
5.563	.352	19.590	19.65	7.064	5.763	3.410	1.847	15.89
6.000	.148	9.250	11.65	3.885	2.721	4.283	2.070	8.741
6.000	.15625	9.751	12.25	4.085	2.869	4.272	2.067	9.190
6.000	.180	11.188	13.95	4.649	3.291	4.238	2.059	10.46
6.000	.1875	11.639	14.47	4.825	3.424	4.228	2.056	10.86
6.000	.203	12.568	15.55	5.183	3.607	4.206	2.051	11.66
6.000	.21875	13.506	16.62	5.541	3.973	4.184	2.045	12.47
6.000	.220	13.580	16.71	5.569	3.995	4.182	2.045	12.53

This information supplements that on pages 60 to 62

PROPERTIES OF PIPE

Definition of Strength Factor "*Q*."

$$Q = 2.25 \frac{I}{y}$$

Strength Factor "*Q*" represents the strength of the pipe to resist bending action, and is the resisting moment in thousands of foot pounds, the stress in the material being 27,000 pounds per square inch. For any other allowable stress in the material the resisting moment is directly proportional.

is information supplements that on pages 58 to 65

Properties of Pipe

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2}\,\frac{I}{\text{O. D.}}$$

y = distance of farthest fiber from axis.

External diameter O. D.	Thickness	Weight per foot	Moment of inertia I	Section modulus I/y	Area of metal, square inches A	Radius of gyration squared $R^2 = I/A$	Radius of gyration R	Strength factor Q
2.500	.165	4.114	.8290	.6632	1.210	.6849	.8276	1.492
2.500	.180	4.460	.8880	.7104	1.312	.6769	.8227	1.598
2.875	.366	9.807	2.318	1.613	2.885	.8036	.8965	3.629
3.000	.180	5.421	1.592	1.061	1.595	.9981	.9990	2.387
4.500	.128	5.976	4.204	1.869	1.758	2.391	1.546	4.204
4.500	.148	6.879	4.796	2.132	2.023	2.370	1.540	4.796
4.500	.165	7.639	5.286	2.349	2.247	2.352	1.534	5.286
4.500	.180	8.304	5.709	2.537	2.443	2.337	1.529	5.709
4.500	.1875	8.635	5.917	2.630	2.540	2.329	1.526	5.917
4.500	.203	9.316	6.339	2.817	2.740	2.313	1.521	6.339
4.500	.3125	13.975	9.061	4.027	4.111	2.204	1.485	9.061
4.750	.1875	9.136	7.005	2.949	2.688	2.606	1.614	6.636
4.750	.250	12.015	8.974	3.778	3.534	2.539	1.593	8.501
4.750	.3125	14.810	10.78	4.537	4.357	2.474	1.573	10.21
5.000	.165	8.520	7.332	2.933	2.506	2.926	1.710	6.599
5.000	.180	9.266	7.926	3.171	2.726	2.908	1.705	7.134
5.000	.1875	9.637	8.219	3.288	2.835	2.899	1.703	7.397
5.000	.203	10.400	8.815	3.526	3.059	2.882	1.698	7.934
5.000	.220	11.231	9.456	3.782	3.304	2.862	1.692	8.510
5.000	.296	14.870	12.15	4.859	4.374	2.777	1.666	10.93
5.000	.3125	15.644	12.70	5.078	4.602	2.759	1.661	11.43
5.250	.1875	10.137	9.566	3.644	2.982	3.208	1.791	8.200
5.250	.250	13.350	12.30	4.687	3.927	3.133	1.770	10.55
5.250	.3125	16.479	14.83	5.650	4.847	3.060	1.749	12.71
5.500	.134	7.679	8.136	2.958	2.259	3.601	1.898	6.656
5.500	.1875	10.638	11.05	4.019	3.129	3.532	1.879	9.044
5.500	.250	14.017	14.24	5.178	4.123	3.453	1.858	11.65
5.500	.3125	17.313	17.19	6.252	5.093	3.376	1.837	14.07
5.563	.1875	10.764	11.45	4.117	3.166	3.616	1.902	9.263
5.563	.250	14.185	14.76	5.305	4.173	3.536	1.881	11.94
5.563	.294	16.544	16.94	6.091	4.867	3.481	1.866	13.70
5.563	.3125	17.523	17.83	6.409	5.155	3.458	1.860	14.42
5.563	.352	19.590	19.65	7.064	5.763	3.410	1.847	15.89
6.000	.148	9.250	11.65	3.885	2.721	4.283	2.070	8.741
6.000	.15625	9.751	12.25	4.085	2.869	4.272	2.067	9.190
6.000	.180	11.188	13.95	4.649	3.291	4.238	2.059	10.46
6.000	.1875	11.639	14.47	4.825	3.424	4.228	2.056	10.86
6.000	.203	12.568	15.55	5.183	3.697	4.206	2.051	11.66
6.000	.21875	13.506	16.62	5.541	3.973	4.184	2.045	12.47
6.000	.220	13.580	16.71	5.569	3.995	4.182	2.045	12.53

This information supplements that on pages 60 to 62

Properties of Pipe (Continued)

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2}\,\frac{I}{\text{O. D.}}$$

y = distance of farthest fiber from axis.

External diameter O. D.	Thickness	Weight per foot	Moment of inertia I	Section modulus I/y	Area of metal, square inches A	Radius of gyration squared $R^2 = I/A$	Radius of gyration R	Strength factor Q
6.000	.238	14.646	17.91	5.970	4.308	4.157	2.039	13.43
6.000	.250	15.352	18.70	6.233	4.516	4.141	2.035	14.02
6.000	.259	15.880	19.28	6.428	4.671	4.128	2.032	14.46
6.625	.180	12.390	18.94	5.717	3.645	5.196	2.280	12.86
6.625	.1875	12.891	19.66	5.935	3.792	5.185	2.277	13.35
6.625	.203	13.923	21.13	6.380	4.096	5.160	2.272	14.36
6.625	.21875	14.966	22.61	6.826	4.403	5.136	2.266	15.36
6.625	.220	15.049	22.73	6.861	4.427	5.134	2.266	15.44
6.625	.238	16.234	24.39	7.362	4.776	5.106	2.260	16.56
6.625	.250	17.021	25.47	7.690	5.007	5.088	2.256	17.30
6.625	.259	17.609	26.28	7.935	5.180	5.074	2.253	17.85
6.625	.28125	19.055	28.25	8.529	5.605	5.040	2.245	19.19
6.625	.284	19.233	28.49	8.601	5.658	5.036	2.244	19.35
6.625	.292	19.750	29.19	8.811	5.810	5.024	2.241	19.83
6.625	.3125	21.068	30.94	9.342	6.197	4.993	2.235	21.02
6.625	.340	22.822	33.24	10.04	6.713	4.952	2.225	22.58
6.625	.352	23.582	34.23	10.33	6.937	4.934	2.221	23.25
6.625	.356	23.835	34.55	10.43	7.011	4.928	2.220	23.47
7.000	.15625	11.420	19.68	5.622	3.359	5.858	2.420	12.65
7.000	.180	13.110	22.44	6.411	3.857	5.818	2.412	14.42
7.000	.1875	13.642	23.30	6.656	4.013	5.806	2.409	14.98
7.000	.203	14.736	25.06	7.159	4.335	5.780	2.404	16.11
7.000	.21875	15.842	26.82	7.662	4.660	5.754	2.399	17.24
7.000	.220	15.930	26.95	7.701	4.686	5.752	2.398	17.33
7.000	.238	17.188	28.93	8.267	5.056	5.723	2.392	18.60
7.000	.250	18.022	30.23	8.639	5.301	5.703	2.388	19.44
7.000	.259	18.646	31.20	8.915	5.485	5.689	2.385	20.06
7.000	.28125	20.181	33.56	9.588	5.937	5.653	2.378	21.57
7.000	.284	20.370	33.84	9.670	5.992	5.648	2.377	21.76
7.000	.300	21.467	35.50	10.14	6.315	5.623	2.371	22.82
7.000	.3125	22.319	36.78	10.51	6.565	5.603	2.367	23.65
7.000	.423	29.712	47.45	13.56	8.740	5.429	2.330	30.51
7.625	.1875	14.893	30.31	7.951	4.381	6.919	2.630	17.89
7.625	.203	16.091	32.62	8.555	4.733	6.891	2.625	19.25
7.625	.21875	17.303	34.93	9.162	5.090	6.863	2.620	20.61
7.625	.220	17.399	35.11	9.209	5.118	6.860	2.619	20.72
7.625	.238	18.776	37.71	9.892	5.523	6.828	2.613	22.26
7.625	.250	19.691	39.43	10.34	5.792	6.807	2.609	23.27
7.625	.259	20.375	40.70	10.68	5.994	6.791	2.606	24.02
7.625	.28125	22.059	43.81	11.49	6.489	6.751	2.598	25.85

his information supplements that on pages 62 and 63

Properties of Pipe (Continued)

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2} \cdot \frac{I}{\text{O. D.}}$$

y = distance of farthest fiber from axis.

External diameter *O. D.*	Thickness	Weight per foot	Moment of inertia *I*	Section modulus *I/y*	Area of metal, square inches *A*	Radius of gyration squared $R^2 = I/A$	Radius of gyration *R*	Strength factor *Q*
7.625	.284	22.266	44.19	11.59	6.550	6.746	2.597	26.08
8.000	.180	15.033	33.82	8.455	4.422	7.648	2.766	19.02
8.000	.1875	15.644	35.13	8.783	4.602	7.634	2.763	19.76
8.000	.203	16.904	37.81	9.453	4.972	7.604	2.758	21.27
8.000	.21875	18.179	40.50	10.13	5.347	7.574	2.752	22.78
8.000	.220	18.280	40.72	10.18	5.377	7.572	2.752	22.90
8.000	.238	19.730	43.75	10.94	5.804	7.538	2.746	24.61
8.000	.250	20.692	45.75	11.44	6.087	7.516	2.741	25.73
8.000	.259	21.412	47.23	11.81	6.299	7.499	2.738	26.57
8.000	.28125	23.185	50.86	12.71	6.820	7.457	2.731	28.61
8.000	.284	23.403	51.30	12.83	6.884	7.452	2.730	28.86
8.000	.300	24.671	53.87	13.47	7.257	7.423	2.724	30.30
8.000	.3125	25.657	55.84	13.96	7.547	7.399	2.720	31.41
8.625	.203	18.259	47.65	11.05	5.371	8.871	2.978	24.86
8.625	.21875	19.639	51.06	11.84	5.777	8.839	2.973	26.64
8.625	.220	19.748	51.33	11.90	5.809	8.837	2.973	26.78
8.625	.238	21.318	55.18	12.80	6.271	8.800	2.966	28.79
8.625	.250	22.361	57.72	13.38	6.578	8.775	2.962	30.12
8.625	.259	23.141	59.61	13.82	6.807	8.757	2.959	31.10
8.625	.28125	25.062	64.23	14.89	7.372	8.712	2.952	33.51
8.625	.284	25.299	64.79	15.02	7.442	8.707	2.951	33.81
8.625	.300	26.673	68.06	15.78	7.846	8.674	2.945	35.51
8.625	.3125	27.743	70.59	16.37	8.161	8.649	2.941	36.83
8.625	.340	30.084	76.06	17.64	8.850	8.595	2.932	39.68
8.625	.34375	30.402	76.80	17.81	8.943	8.587	2.930	40.07
8.625	.375	33.041	82.86	19.21	9.719	8.525	2.920	43.23
8.625	.40625	35.659	88.78	20.59	10.49	8.464	2.909	46.32
8.625	.4375	38.256	94.56	21.93	11.25	8.403	2.899	49.34
9.000	.1875	17.647	50.41	11.20	5.191	9.712	3.116	25.21
9.000	.203	19.072	54.30	12.07	5.610	9.679	3.111	27.15
9.000	.21875	20.515	58.20	12.93	6.035	9.645	3.106	29.10
9.000	.220	20.629	58.51	13.00	6.068	9.642	3.105	29.26
9.000	.238	22.271	62.92	13.98	6.551	9.604	3.099	31.46
9.000	.259	24.179	67.99	15.11	7.112	9.559	3.092	33.99
9.000	.28125	26.189	73.28	16.28	7.704	9.512	3.084	36.64
9.000	.284	26.437	73.92	16.43	7.777	9.506	3.083	36.96
9.000	.300	27.875	77.67	17.26	8.200	9.473	3.078	38.84
9.625	.180	18.157	59.58	12.38	5.341	11.16	3.340	27.86
9.625	.1875	18.898	61.92	12.87	5.559	11.14	3.337	28.95
9.625	.203	20.427	66.71	13.86	6.009	11.10	3.332	31.19

This information supplements that on page 68

Properties of Pipe (Continued)

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2}\,\frac{I}{\text{O. D.}}$$

y = distance of farthest fiber from axis.

External diameter *O. D.*	Thickness	Weight per foot	Moment of inertia I	Section modulus I/y	Area of metal, square inches A	Radius of gyration squared $R^2=I/A$	Radius of gyration R	Strength factor Q
9.625	.21875	21.975	71.53	14.86	6.464	11.07	3.327	33.44
9.625	.220	22.098	71.91	14.94	6.500	11.06	3.326	33.62
9.625	.238	23.860	77.36	16.07	7.019	11.02	3.320	36.17
9.625	.250	25.031	80.95	16.82	7.363	10.99	3.316	37.85
9.625	.259	25.907	83.63	17.38	7.621	10.97	3.313	39.10
9.625	.28125	28.066	90.18	18.74	8.256	10.92	3.305	42.16
9.625	.284	28.332	90.98	18.91	8.334	10.92	3.304	42.54
9.625	.300	29.877	95.63	19.87	8.789	10.88	3.299	44.71
9.625	.3125	31.080	99.22	20.62	9.143	10.85	3.294	46.39
9.625	.340	33.716	107.0	22.24	9.918	10.79	3.285	50.04
9.625	.625	60.075	179.8	37.36	17.67	10.17	3.190	84.06
9.625	.750	71.089	207.4	43.09	20.91	9.916	3.149	96.95
9.625	.875	81.769	232.5	48.31	24.05	9.666	3.109	108.7
9.625	1.000	92.116	255.4	53.06	27.10	9.424	3.070	119.4
10.000	.180	18.878	66.96	13.39	5.553	12.06	3.472	30.13
10.000	.1875	19.649	69.59	13.92	5.780	12.04	3.470	31.32
10.000	.21875	22.851	80.43	16.09	6.722	11.97	3.459	36.19
10.000	.220	22.979	80.86	16.17	6.759	11.96	3.459	36.39
10.000	.238	24.813	87.00	17.40	7.299	11.92	3.452	39.15
10.000	.250	26.032	91.05	18.21	7.658	11.89	3.448	40.97
10.000	.259	26.945	94.08	18.82	7.926	11.87	3.445	42.33
10.000	.28125	29.193	101.5	20.29	8.587	11.82	3.438	45.66
10.000	.284	29.470	102.4	20.48	8.669	11.81	3.437	46.07
10.000	.300	31.079	107.6	21.52	9.142	11.77	3.431	48.43
10.000	.3125	32.332	111.7	22.34	9.511	11.74	3.427	50.26
10.000	.340	35.077	120.5	24.10	10.32	11.68	3.417	54.23
10.750	.203	22.866	93.56	17.41	6.726	13.91	3.730	39.17
10.750	.21875	24.604	100.4	18.67	7.237	13.87	3.724	42.02
10.750	.220	24.741	100.9	18.77	7.278	13.87	3.724	42.24
10.750	.238	26.720	108.6	20.21	7.860	13.82	3.718	45.47
10.750	.250	28.035	113.7	21.16	8.247	13.79	3.713	47.60
10.750	.259	29.019	117.5	21.86	8.536	13.77	3.710	49.19
10.750	.28125	31.445	126.8	23.59	9.250	13.71	3.703	53.08
10.750	.284	31.745	127.9	23.80	9.338	13.70	3.702	53.56
10.750	.300	33.482	134.6	25.03	9.849	13.66	3.696	56.32
10.750	.625	67.585	255.7	47.58	19.88	12.86	3.587	107.0
10.750	.750	80.101	296.2	55.10	23.56	12.57	3.545	124.0
10.750	.875	92.283	333.5	62.04	27.15	12.29	3.505	139.6
10.750	1.000	104.131	367.8	68.43	30.63	12.01	3.465	154.0
11.000	.203	23.408	100.4	18.25	6.886	14.58	3.818	41.06

This information supplements that on pages 63 and 64

Properties of Pipe (Continued)

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2}\,\frac{I}{\text{O. D.}}$$

y = distance of farthest fiber from axis.

External diameter O. D.	Thickness	Weight per foot	Moment of inertia I	Section modulus I/y	Area of metal, square inches A	Radius of gyration squared $R^2=I/A$	Radius of gyration R	Strength factor Q
11.000	.21875	25.188	107.7	19.58	7.409	14.54	3.813	44.06
11.000	.238	27.355	116.6	21.19	8.047	14.48	3.806	47.68
11.000	.250	28.702	122.0	22.19	8.443	14.45	3.802	49.92
11.000	.259	29.711	126.1	22.93	8.740	14.43	3.799	51.59
11.000	.28125	32.196	136.1	24.75	9.471	14.37	3.791	55.68
11.000	.284	32.503	137.3	24.97	9.561	14.36	3.790	56.18
11.000	.300	34.283	144.4	26.26	10.08	14.32	3.785	59.09
11.000	.3125	35.670	149.9	27.26	10.49	14.29	3.780	61.34
11.000	.340	38.709	161.9	29.44	11.39	14.22	3.771	66.23
11.750	.203	25.034	122.8	20.90	7.364	16.67	4.083	47.02
11.750	.21875	26.940	131.8	22.43	7.925	16.63	4.078	50.46
11.750	.220	27.091	132.5	22.55	7.969	16.62	4.077	50.73
11.750	.238	29.262	142.7	24.28	8.608	16.57	4.071	54.63
11.750	.250	30.705	149.4	25.43	9.032	16.54	4.067	57.21
11.750	.259	31.785	154.4	26.28	9.350	16.51	4.064	59.13
11.750	.28125	34.449	166.7	28.38	10.13	16.45	4.056	63.85
11.750	.284	34.778	168.2	28.63	10.23	16.44	4.055	64.43
11.750	.300	36.686	177.0	30.12	10.79	16.40	4.050	67.78
11.750	.3125	38.173	183.7	31.28	11.23	16.36	4.045	70.37
11.750	.340	41.432	198.5	33.79	12.19	16.29	4.036	76.02
11.750	.34375	41.875	200.5	34.13	12.32	16.28	4.035	76.79
11.750	.625	74.260	339.0	57.70	21.84	15.52	3.939	129.8
11.750	.750	88.111	393.8	67.04	25.92	15.20	3.898	150.8
11.750	.875	101.628	444.8	75.71	29.89	14.88	3.857	170.3
11.750	1.000	114.811	492.1	83.76	33.77	14.57	3.817	188.5
12.000	.203	25.576	130.9	21.82	7.523	17.40	4.171	49.09
12.000	.21875	27.524	140.5	23.42	8.096	17.36	4.166	52.69
12.000	.220	27.678	141.3	23.55	8.142	17.35	4.166	52.98
12.000	.238	29.897	152.1	25.36	8.794	17.30	4.159	57.05
12.000	.2485	31.188	158.4	26.41	9.174	17.27	4.156	59.41
12.000	.250	31.372	159.3	26.56	9.228	17.27	4.155	59.75
12.000	.259	32.477	164.7	27.45	9.553	17.24	4.152	61.76
12.000	.2715	34.008	172.1	28.68	10.00	17.20	4.148	64.54
12.000	.28125	35.200	177.8	29.64	10.35	17.18	4.144	66.69
12.000	.284	35.536	179.5	29.91	10.45	17.17	4.143	67.30
12.000	.292	36.512	184.1	30.69	10.74	17.15	4.141	69.05
12.000	.300	37.487	188.8	31.47	11.03	17.12	4.138	70.80
12.000	.3125	39.007	196.1	32.68	11.47	17.09	4.134	73.52
12.000	.320	39.918	200.4	33.40	11.74	17.07	4.131	75.14
12.000	.340	42.340	211.8	35.31	12.45	17.01	4.124	79.44

This information supplements that on page 61

Properties of Pipe (Continued)

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2} \frac{I}{\text{O. D.}}$$

y = distance of farthest fiber from axis.

External diameter O. D.	Thickness	Weight per foot	Moment of inertia I	Section modulus I/y	Area of metal, square inches A	Radius of gyration squared $R^2=I/A$	Radius of gyration R	Strength factor Q
12.000	.34375	42.793	214.0	35.66	12.59	17.09	4.123	80.24
12.750	.203	27.202	157.5	24.71	8.002	19.68	4.437	55.59
12.750	.21875	29.276	169.1	26.52	8.612	19.64	4.431	59.68
12.750	.220	29.440	170.0	26.67	8.660	19.63	4.431	60.00
12.750	.238	31.803	183.1	28.73	9.355	19.58	4.424	64.64
12.750	.250	33.375	191.8	30.09	9.817	19.54	4.420	67.70
12.750	.259	34.552	198.3	31.11	10.16	19.51	4.417	69.99
12.750	.28125	37.453	214.2	33.60	11.02	19.44	4.409	75.60
12.750	.284	37.811	216.2	33.91	11.12	19.44	4.409	76.29
12.750	.300	39.890	227.5	35.68	11.73	19.39	4.403	80.29
12.750	.3125	41.510	236.3	37.06	12.21	19.35	4.399	83.38
12.750	.340	45.063	255.4	40.06	13.26	19.27	4.389	90.13
12.750	.34375	45.547	258.0	40.46	13.40	19.25	4.388	91.05
12.750	.625	80.935	438.7	68.81	23.81	18.43	4.293	154.8
12.750	.750	96.121	510.9	80.15	28.27	18.07	4.251	180.3
12.750	.875	110.973	578.5	90.75	32.64	17.72	4.210	204.2
12.750	1.000	125.491	641.7	100.7	36.91	17.38	4.160	226.5
13.000	.203	27.744	167.1	25.71	8.161	20.48	4.525	57.84
13.000	.21875	29.860	179.4	27.60	8.784	20.43	4.520	62.10
13.000	.220	30.028	180.4	27.75	8.833	20.42	4.519	62.44
13.000	.250	34.043	203.6	31.32	10.01	20.33	4.509	70.46
13.000	.28125	38.204	227.4	34.98	11.24	20.23	4.498	78.70
13.000	.284	38.569	229.4	35.30	11.35	20.22	4.497	79.42
13.000	.300	40.691	241.5	37.15	11.97	20.17	4.491	83.58
13.000	.3125	42.345	250.8	38.58	12.46	20.13	4.487	86.81
13.000	.340	45.971	271.1	41.71	13.52	20.05	4.478	93.85
13.000	.34375	46.464	273.9	42.13	13.67	20.04	4.476	94.80
13.000	.390	52.523	307.4	47.29	15.45	19.90	4.460	106.4
14.000	.21875	32.196	224.9	32.13	9.471	23.75	4.873	72.29
14.000	.220	32.377	226.1	32.30	9.524	23.74	4.873	72.68
14.000	.238	34.981	243.7	34.81	10.29	23.68	4.866	78.32
14.000	.259	38.009	264.0	37.71	11.18	23.61	4.859	84.85
14.000	.28125	41.208	285.3	40.75	12.12	23.54	4.851	91.70
14.000	.284	41.602	287.9	41.13	12.24	23.53	4.850	92.54
14.000	.300	43.895	303.1	43.30	12.91	23.47	4.845	97.42
14.000	.3125	45.682	314.9	44.98	13.44	23.43	4.841	101.2
14.000	.340	49.602	340.5	48.65	14.59	23.34	4.831	109.5
14.000	.34375	50.136	344.0	49.14	14.75	23.33	4.830	110.6
14.000	.40625	58.980	401.1	57.30	17.35	23.12	4.808	128.9
14.000	.4375	63.371	429.1	61.29	18.64	23.02	4.798	137.9

This information supplements that on pages 64 and 65

Properties of Pipe (Continued)

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2}\,\frac{I}{\text{O. D.}}$$

y = distance of farthest fiber from axis.

External diameter O. D.	Thickness	Weight per foot	Moment of inertia I	Section modulus I/y	Area of metal, square inches A	Radius of gyration squared $R^2=I/A$	Radius of gyration R	Strength factor Q
14.000	.46875	67.741	456.6	65.23	19.93	22.91	4.787	146.8
14.000	.5625	80.726	536.9	76.70	23.75	22.61	4.755	172.6
14.000	.625	89.279	588.5	84.08	26.26	22.41	4.734	189.2
14.000	.6875	97.748	638.7	91.24	28.75	22.21	4.713	205.3
14.000	.750	106.134	687.3	98.19	31.22	22.02	4.692	220.9
14.000	.875	122.654	780.4	111.5	36.08	21.63	4.651	250.8
14.000	1.000	138.842	867.9	124.0	40.84	21.25	4.610	279.0
14.000	1.125	154.695	950.1	135.7	45.50	20.88	4.569	305.4
15.000	.238	37.523	300.7	40.10	11.04	27.25	5.220	90.22
15.000	.250	39.383	315.1	42.02	11.58	27.20	5.216	94.54
15.000	.28125	44.212	352.3	46.97	13.01	27.09	5.205	105.7
15.000	.284	44.636	355.6	47.41	13.13	27.08	5.204	106.7
15.000	.300	47.099	374.4	49.92	13.85	27.02	5.198	112.3
15.000	.3125	49.020	389.0	51.87	14.42	26.98	5.194	116.7
15.000	.340	53.234	420.9	56.12	15.66	26.88	5.184	126.3
15.000	.34375	53.807	425.2	56.70	15.83	26.87	5.183	127.6
15.000	.40625	63.319	496.2	66.17	18.63	26.64	5.162	148.9
15.000	.4375	68.044	531.1	70.81	20.02	26.53	5.151	159.3
15.000	.46875	72.748	565.4	75.39	21.40	26.42	5.140	169.6
15.000	.5625	86.734	665.8	88.77	25.51	26.09	5.108	199.7
15.000	.625	95.954	730.4	97.39	28.23	25.88	5.087	219.1
15.000	.6875	105.091	793.4	105.8	30.91	25.67	5.066	238.0
15.000	.750	114.144	854.6	113.9	33.58	25.45	5.045	256.4
15.000	.875	132.000	972.1	129.6	38.83	25.04	5.004	291.6
15.000	1.000	149.522	1083.	144.4	43.98	24.63	4.962	324.9
15.000	1.125	166.710	1188.	158.4	49.04	24.22	4.922	356.4
16.000	.238	40.065	366.1	45.76	11.79	31.06	5.573	103.0
16.000	.250	42.053	383.7	47.96	12.37	31.02	5.569	107.9
16.000	.259	43.542	396.8	49.60	12.81	30.98	5.566	111.6
16.000	.28125	47.215	429.1	53.64	13.89	30.89	5.558	120.7
16.000	.284	47.669	433.1	54.13	14.02	30.88	5.557	121.8
16.000	.300	50.303	456.1	57.01	14.80	30.82	5.552	128.3
16.000	.3125	52.357	474.0	59.25	15.40	30.77	5.547	133.3
16.000	.340	56.865	513.0	64.13	16.73	30.67	5.538	144.3
16.000	.34375	57.478	518.3	64.79	16.91	30.65	5.537	145.8
16.000	.40625	67.658	605.3	75.67	19.90	30.42	5.515	170.3
16.000	.4375	72.716	648.1	81.01	21.39	30.30	5.504	182.3
16.000	.46875	77.754	690.3	86.28	22.87	30.18	5.494	194.1
16.000	.5625	92.742	813.7	101.7	27.28	29.83	5.462	228.9
16.000	.625	102.629	893.5	111.7	30.19	29.60	5.440	251.3

This information supplements that on page 65

Properties of Pipe (Concluded)

$$\text{Strength factor } Q = \frac{\text{foot pounds}}{1000} = \frac{I}{y} \times \frac{27000}{1000} \times \frac{1}{12} = \frac{9}{2}\,\frac{I}{O.\,D.}$$

y = distance of farthest fiber from axis.

External diameter O. D.	Thickness	Weight per foot	Moment of inertia I	Section modulus I/y	Area of metal, square inches A	Radius of gyration squared $R^2 = I/A$	Radius of gyration R	Strength factor Q
22.000	.34375	79.506	1371.	124.7	23.39	58.64	7.658	280.5
22.000	.375	86.609	1490.	135.4	25.48	58.47	7.647	304.7
22.000	.40625	93.691	1607.	146.1	27.56	58.31	7.636	328.7
22.000	.4375	100.752	1723.	156.6	29.64	58.14	7.625	352.5
22.000	.46875	107.792	1838.	167.1	31.71	57.98	7.614	376.0
22.000	.500	114.811	1952.	177.5	33.77	57.81	7.603	399.4
22.000	.5625	128.787	2178.	198.0	37.88	57.49	7.582	445.4
22.000	.625	142.680	2399.	218.1	41.97	57.16	7.560	490.7
22.000	.6875	156.489	2616.	237.8	46.03	56.84	7.539	535.2
22.000	.750	170.215	2830.	257.2	50.07	56.52	7.518	578.8
24.000	.340	85.915	1769.	147.4	25.27	69.99	8.366	331.6
24.000	.34375	86.849	1787.	149.0	25.55	69.97	8.365	335.1
24.000	.375	94.619	1942.	161.9	27.83	69.79	8.354	364.2
24.000	.40625	102.368	2096.	174.7	30.11	69.60	8.343	393.0
24.000	.4375	110.097	2248.	187.4	32.39	69.42	8.332	421.6
24.000	.46875	117.805	2399.	200.0	34.65	69.24	8.321	449.9
24.000	.500	125.491	2549.	212.4	36.91	69.06	8.310	478.0
24.000	.5625	140.802	2846.	237.1	41.42	68.70	8.289	533.5
24.000	.625	156.030	3137.	261.4	45.90	68.35	8.267	588.2
24.000	.6875	171.174	3424.	285.3	50.35	67.99	8.246	641.9
24.000	.750	186.235	3705.	308.8	54.78	67.64	8.224	694.8
26.000	.375	102.629	2478.	190.6	30.19	82.10	9.061	429.0
26.000	.4375	119.442	2871.	220.8	35.13	81.70	9.039	496.8
26.000	.500	136.172	3257.	250.5	40.06	81.31	9.017	563.7
26.000	.5625	152.818	3638.	279.8	44.95	80.92	8.996	629.6
26.000	.625	169.380	4013.	308.7	49.82	80.54	8.974	694.5
26.000	.6875	185.859	4382.	337.1	54.67	80.15	8.953	758.4
26.000	.750	202.255	4746.	365.0	59.49	79.77	8.931	821.3
28.000	.4375	128.787	3598.	257.0	37.88	94.99	9.746	578.3
28.000	.500	146.852	4085.	291.8	43.20	94.56	9.724	656.5
28.000	.5625	164.833	4565.	326.0	48.49	94.14	9.703	733.6
28.000	.625	182.730	5038.	359.8	53.75	93.72	9.681	809.6
28.000	.6875	200.545	5504.	393.2	58.99	93.31	9.659	884.6
28.000	.750	218.275	5964.	426.0	64.21	92.89	9.638	958.5
30.000	.4375	138.132	4440.	296.0	40.63	109.3	10.45	666.0
30.000	.500	157.532	5042.	336.1	46.34	108.8	10.43	756.3
30.000	.5625	176.848	5637.	375.8	52.02	108.4	10.41	845.5
30.000	.625	196.081	6224.	414.9	57.68	107.9	10.39	933.6
30.000	.6875	215.230	6803.	453.6	63.31	107.5	10.37	1021.
30.000	.750	234.296	7375.	491.7	68.92	107.0	10.34	1106.

his information supplements that on page 65

Hydrostatic Test Pressures

Page 68
"NATIONAL" Standard Pipe—Black and Galvanized

Size	Weight per foot complete	Test pressure in pounds
17 O. D.	72.602	600
18 O. D.	80.482	600
20 O. D.	89.617	500

Page 68
"NATIONAL" Line Pipe

Size	Weight per foot complete	Test pressure in pounds	
		Butt	Lap
1¼	2.300	1200	1700
17 O. D.	72.769	....	750
18 O. D.	80.659	....	700
20 O. D.	89.794	....	650

Page 69
"NATIONAL" Extra Strong Pipe—Black and Galvanized

Size	Weight per foot plain ends	Test pressure in pounds	
		Butt	Lap
1¼	2.996	1500	2500

Page 69
"NATIONAL" Double Extra Strong Pipe—Black and Galvanized

Size	Weight per foot plain ends	Test pressure in pounds
½	1.714	700
¾	2.440	700
1	3.659	700

In addition to the above test the pipe is jarred with a hammer while under pressure, for these sizes only.

Page 71
"NATIONAL" California Diamond BX Casing

Size	Weight per foot Complete	Test pressure in pounds
4½	16.000	1800
4¾	12.850	1400
4¾	15.000	1700
6⅝	24.000	1300
11	47.000	900
11	60.000	1200
12½	54.000	1000

Page 71
"NATIONAL" South Penn Casing

Size	Weight per foot complete	Test pressure in pounds
6¼	20.000	1200
6¼	24.000	1500
12½	45.000	700

This information supplements that on pages 68, 69 and 71

Hydrostatic Test Pressures (Continued)

"NATIONAL" Standard Boiler Tubes and Flues—Lap Welded

External Diameter Inches	Nominal Thickness Inches	Nominal Thickness B. W. G.	Weight per foot	Test pressure in pounds
1¾	.095	13	1.679	1000
2	.095	13	1.932	1000
2¼	.095	13	2.186	1000
2½	.109	12	2.783	1000
2¾	.109	12	3.074	1000
3	.109	12	3.365	1000
3¼	.120	11	4.011	1000
3½	.120	11	4.331	1000
3¾	.120	11	4.652	1000
4	.134	10	5.532	1000
4½	.134	10	6.248	1000
5	.148	9	7.669	800
6	.165	8	10.282	800
7	.165	8	12.044	500
8	.165	8	13.807	500
9	.180	7	16.955	500
10	.203	6	21.240	500
11	.220	5	25.329	500
12	.229	..	28.788	500
13	.238	4	32.439	500
14	.248	..	36.424	500
15	.259	3	40.775	500
16	.270	..	45.359	500

"NATIONAL" Locomotive Boiler Tubes—Lap Welded—Open-Hearth Steel

External diameter	Thickness	Test pressure in pounds	External diameter	Thickness	Test pressure in pounds
1¾	.095	1000	2¼	.148	1000
1¾	.109	1000	2¼	.150	1000
1¾	.110	1000	2½	.095	1000
1¾	.120	1000	2½	.109	1000
1¾	.125	1000	2½	.110	1000
1¾	.134	1000	2½	.120	1000
1¾	.135	1000	2½	.125	1000
1¾	.148	1000	2½	.134	1000
1¾	.150	1000	2½	.135	1000
2	.095	1000	2½	.148	1000
2	.109	1000	2½	.150	1000
2	.110	1000	2½	.165	1000
2	.120	1000	2½	.180	1000
2	.125	1000	3	.095	1000
2	.134	1000	3	.109	1000
2	.135	1000	3	.110	1000
2	.148	1000	3	.120	1000
2	.150	1000	3	.125	1000
2¼	.095	1000	3	.134	1000
2¼	.109	1000	3	.135	1000
2¼	.110	1000	3	.148	1000
2¼	.120	1000	3	.150	1000
2¼	.125	1000	3	.165	1000
2¼	.134	1000	3	.180	1000
2¼	.135	1000			

This information supplements that on page [illegible]

Hydrostatic Test Pressures (Concluded)

Page 73
"NATIONAL" Air Line Pipe

Size	Weight per foot complete	Test pressure in pounds
4	12.500	1800

This size is included in the list on page 73, but the weight and dimension data has been revised.

Page 76
"NATIONAL" Dry Kiln Pipe

Size	Weight per foot complete	Test pressure in pounds
¾	1.140	700

In addition to the above test, the pipe is jarred with a hammer while under pressure.

Page 76
"NATIONAL" Special Upset Rotary Pipe

Size	Weight per foot complete	Test pressure in pounds
3	10.486	2000
4½	15.737	1600
6	23.566	1500

In addition to the Hydrostatic Test, all sizes of "NATIONAL" Special Upset Rotary Pipe are jarred with a hammer while under pressure.

Page 76
"NATIONAL" California Special External Upset Tubing

Size	Weight per foot complete	Test pressure in pounds
1¼	2.300	1800
2	4.000	2200
2	4.500	2500
2½	6.250	2200

Page 76
"NATIONAL" Tuyere Pipe

Size	Weight per foot plain ends	Test pressure in pounds
¾	1.473	700
1	2.171	700
1¼	2.996	1500
1½	3.631	1500

In addition to the above test, on sizes ¾ inch and 1 inch, the pipe is jarred with a hammer while under pressure.

"NATIONAL" Ammonia Pipe, Specially Recommended for Ammonia Purposes

(For weights and dimensions, see page 597).

Size	Weight per foot complete	Test pressure in pounds: Butt	Test pressure in pounds: Lap
¾	1.137	1500	....
1	1.686	1500	....
1¼	2.297	1500	....
1½	2.744	1500	....
2	3.706	....	2000

This information supplements that on pages 73, 76 and 68 to 76

PAGE 83

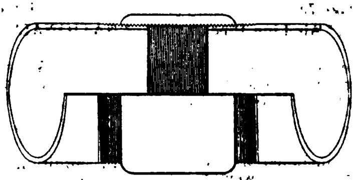

Fig. 216

Illustration from corrected drawing showing typical section of "NATIONAL" Dry Kiln Pipe Coupling and Joint
(For list of sizes, dimensions and weights, see pages 37 and 596.)

PAGE 84

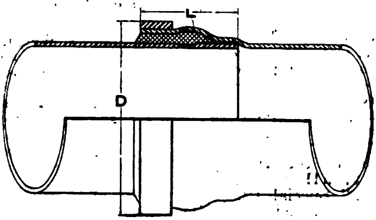

Fig. 217

Illustration from corrected drawing showing typical section of a "NATIONAL" Matheson Joint
(For list of sizes, dimensions and weights, see page 42.)

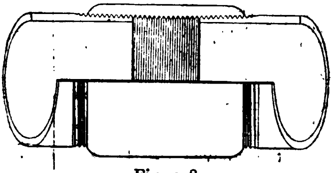

Fig. 218

Typical Section of "NATIONAL" Ammonia Pipe Coupling and Joint
(For list of sizes, dimensions and weights, see page 597.)

Directions for Making Tight Joints—Before screwing lengths of pipe together, see that threads on pipe and in couplings (also recesses in the ends of couplings) are thoroughly cleaned and free from damage spots.

STANDARD SPECIFICATIONS

Practically all the specifications appearing in the 1913 edition of the Book of Standards have been modified more or less and are now void. Specifications represent practice or requirements which constantly change with the progress of the art, so that no attempt has been made in this appendix to include revised specifications.

All specifications covering products of National Tube Company are printed in loose leaf form and copies of any or all of the latest specifications will be sent upon request to the General Offices of National Tube Company, Frick Building, Pittsburgh, Pa., or to any of the District Offices.

This information supplements that on pages 89 to 105, and 119

WIND LOADS. SLEET, ICE AND SNOW

The rules of page 117, etc., are based on strength at elastic limit and may be the most appropriate, but other rules of loading are much approved, as, for example, the following:

W. R. King gave account of destructive sleet storms in Oregon (see Engineering Record, March 8, 1913, page 271), and recorded measures of thickness of ice (sleet) which justified the rule that the diameter over the sleet is closely 1.81 times the fourth root of the diameter of the wire (both diameters in inches).

The Joint Committee on Overhead Construction (Trans. N. E. L. A., 1911, Vol. 11, page 521), recommended design on the basis of ½-inch thickness of ice and a wind pressure of eight pounds per square foot of area.

The same rule is recommended by the American Electric Railway Association, Proceedings 1913, page 143.

Pender's Electrical Engineer's Handbook, page 1688, states that the following are recommended:

(a) No ice but 15 pound wind,
(b) Ice ½ inch thick and 8-pound wind,
(c) Ice ¾ inch thick and 11-pound wind.

On the same page, Pender notes that important structures have been designed to stand 6-pound wind with ½ inch thickness of ice.

In the above, the wind pressure should be reckoned on an area equal to the diameter (over ice, if any) by the length, both in feet. It will be noted that rule (a) and the rule on page 117 yield indentical results when ice and surging are ignored.

The German I. E. E. state that wind pressure to the extent of 20.5 pounds per square foot on the projected area should be allowed for, and that ample margin should be left for snow deposits

'his information supplements that on pages 116 to 118

WROUGHT PIPE BENDS

Page 162.

Hot Bending. Please note that the information given on page 162 with regard to wrought pipe bends applies only to hot bending.

Page 163.

Symbols. It will be noticed that there are various symbols shown on the drawings on page 163. All these are to be disregarded with the exception of the symbol "R," Advisable Radius to which reference is made in table on page 162.

Wrought Pipe Nipples

Page 171.
The length of Close Nipples should be changed as shown in the list below, which conforms to the standard adopted by the Committee of Manufacturers on Standardization of Fittings and Valves, on April 19, 1916, New York, N. Y.

Pipe Size	Length of Close Nipple	Pipe Size	Length of Close Nipple
1/8	3/4	3 1/2	2 3/4
1/4	7/8	4	2 7/8
3/8	1	4 1/2	2 7/8
1/2	1 1/8	5	3
3/4	1 3/8	6	3 1/8
1	1 1/2	7	3 1/4
1 1/4	1 5/8	8	3 1/2
1 1/2	1 3/4	9	3 5/8
2	2	10	3 7/8
2 1/2	2 1/2	12	4 1/2
3	2 5/8		

This information supplements that on pages 162, 163 and 171

Page 174 **Wrought Casing Nipples**

We give below the length of Close and Short Casing Nipples, sizes 2 to 15½ inches, inclusive. These are made from the lightest weight of Standard Boston Casing, and with the standard number of threads per inch for that weight, unless otherwise ordered.

Casing size, inches	Total length close nipple, inches	Total length short nipple, inches
2	2½	3
2¼	2½	3
2½	2½	3
2¾	2½	3
3	2½	3
3¼	2¾	4
3½	2¾	4
3¾	2¾	4
4	3	4
4¼	3	4
4½	3	4
4¾	3	4
5	3	4
5 3/16	3	4
5⅝	3	4
6¼	3¼	4½
6⅝	3¼	4½
7¼	3½	4½
7⅝	3¾	5
8¼	4	5
8⅝	4	5
9⅝	4	5½
10⅝	4¼	5½
11⅝	4½	5½
12½	5	6
13½	5	6
14½	5¼	6½
15½	5¼	6½

is information supplements that on page 174.

WORKING BARRELS

Present foot note reads:

"All Working Barrels are threaded 14 threads per inch."

This should read as follows:

"2 and 2½-inch Working Barrels are threaded 11½ threads per inch."

"3 and 4-inch Working Barrels are threaded 14 threads per inch."

This information supplements that on page 187

The following tables showing the "Internal Fluid Pressures for Standard, Extra Strong, Double Extra Strong Pipe and Standard Boiler Tubes and Flues supplement the information on "Strength of Commercial Tubes, Pipes and Cylinders to Resist Internal Fluid Pressures," which appears on pages 222 to 226.

'his information supplements that on pages 222 to 226

Internal Fluid Pressures for Standard Pipe

Based on Barlow's Formula $P = 2f\dfrac{t}{D}$

D = Outside diameter in inches.
t = Thickness of wall in inches.
P = Pressure in pounds per square inch.
f = Fiber stress in pounds per square inch.

Size	External diameter	Thickness	Ultimate bursting pressure: Butt-weld, Fiber stress 40,000 lbs. per sq. in.	Ultimate bursting pressure: Lap-weld, Fiber stress 50,000 lbs. per sq. in.	Pressures at various factors of safety: Factor of safety = 5, Butt-weld fiber stress = 8000 lbs. per sq. in.	Factor of safety = 5, Lap-weld fiber stress = 10000 lbs. per sq. in.	Factor of safety = 6, Butt-weld fiber stress = 6667 lbs. per sq. in.	Factor of safety = 6, Lap-weld fiber stress = 8333 lbs. per sq. in.	Factor of safety = 8, Butt-weld fiber stress = 5000 lbs. per sq. in.	Factor of safety = 8, Lap-weld fiber stress = 6250 lbs. per sq. in.	Factor of safety = 10, Butt-weld fiber stress = 4000 lbs. per sq. in.	Factor of safety = 10, Lap-weld fiber stress = 5000 lbs. per sq. in.
1/8	.405	.068	13432	....	2686	....	2239	....	1679	....	1343	....
1/4	.540	.088	13037	....	2607	....	2173	....	1630	....	1304	....
3/8	.675	.091	10785	....	2157	....	1798	....	1348	....	1079	....
1/2	.840	.109	10381	....	2076	....	1730	....	1298	....	1038	....
3/4	1.050	.113	8610	....	1722	....	1435	....	1076	....	861	....
1	1.315	.133	8091	....	1618	....	1340	....	1011	....	809	....
1 1/4	1.660	.140	6747	8434	1349	1687	1124	1406	843	1054	675	843
1 1/2	1.900	.145	6105	7632	1221	1526	1018	1272	763	954	611	763
2	2.375	.154	5187	6484	1037	1297	865	1081	648	811	519	648
2 1/2	2.875	.203	5649	7061	1130	1412	941	1177	706	883	565	706
3	3.500	.216	4937	6171	987	1234	823	1029	617	771	494	617
3 1/2	4.000	.226	....	5650	....	1130	....	942	....	706	....	565
4	4.500	.237	....	5267	....	1053	....	878	....	658	....	527
4 1/2	5.000	.247	....	4940	....	988	....	823	....	618	....	494
5	5.563	.258	....	4638	....	928	....	773	....	580	....	464
6	6.625	.280	....	4226	....	845	....	704	....	528	....	423
7	7.625	.301	....	3948	....	790	....	658	....	493	....	395
8	8.625	.277	....	3212	....	642	....	535	....	401	....	321
8	8.625	.322	....	3733	....	747	....	622	....	467	....	373
9	9.625	.342	....	3553	....	711	....	592	....	444	....	355
10	10.750	.279	....	2595	....	519	....	433	....	324	....	260
10	10.750	.307	....	2856	....	571	....	476	....	357	....	286
10	10.750	.365	....	3395	....	679	....	566	....	424	....	340
11	11.750	.375	....	3191	....	638	....	532	....	399	....	319
12	12.750	.330	....	2588	....	518	....	431	....	324	....	259
12	12.750	.375	....	2941	....	588	....	490	....	368	....	294
13	14.000	.375	....	2679	....	536	....	446	....	335	....	268
14	15.000	.375	....	2500	....	500	....	417	....	313	....	250
15	16.000	.375	....	2344	....	469	....	391	....	293	....	234
17 O. D.	17.000	.393	....	2312	....	462	....	385	....	289	....	231
18 O. D.	18.000	.409	....	2272	....	454	....	379	....	284	....	227
20 O. D.	20.000	.409	....	2045	....	409	....	342	....	256	....	205

Based on Barlow's Formula $P = 2f \frac{t}{D}$

D = Outside diameter in inches. P = Pressure in pounds per square inch.
t = Thickness of wall in inches. f = Fiber stress in pounds per square inch.

Size	External diameter	Thickness	Ultimate bursting pressure		Pressures at various factors of safety							
			Butt-weld	Lap-weld	Factor of safety = 5		Factor of safety = 6		Factor of safety = 8		Factor of safety = 10	
			Fiber stress 40,000 lbs. per sq. in.	Fiber stress 50,000 lbs. per sq. in.	Butt-weld fiber stress = 8000 lbs. per sq. in.	Lap-weld fiber stress = 10000 lbs. per sq. in.	Butt-weld fiber stress = 6667 lbs. per sq. in.	Lap-weld fiber stress = 8333 lbs. per sq. in.	Butt-weld fiber stress = 5000 lbs. per sq. in.	Lap-weld fiber stress = 6250 lbs. per sq. in.	Butt-weld fiber stress = 4000 lbs. per sq. in.	Lap-weld fiber stress = 5000 lbs. per sq. in.
1/8	.405	.095	18765	....	3753	....	3128	....	2346	....	1877	....
1/4	.540	.119	17630	....	3526	....	2938	....	2204	....	1763	....
3/8	.675	.126	14933	....	2987	....	2489	....	1867	....	1493	....
1/2	.840	.147	14000	....	2800	....	2333	....	1750	....	1400	....
3/4	1.050	.154	11733	....	2347	....	1956	....	1467	....	1173	....
1	1.315	.179	10890	....	2178	....	1815	....	1361	....	1089	....
1 1/4	1.660	.191	9205	11506	1841	2301	1534	1918	1151	1438	920	1151
1 1/2	1.900	.200	8421	10526	1684	2105	1404	1754	1053	1316	842	1053
2	2.375	.218	7343	9179	1469	1836	1224	1530	918	1147	734	918
2 1/2	2.875	.276	7680	9600	1536	1920	1280	1600	960	1200	768	960
3	3.500	.300	6857	8571	1371	1714	1143	1429	857	1071	686	857
3 1/2	4.000	.318	....	7950	....	1590	....	1325	....	994	....	795
4	4.500	.337	....	7489	....	1498	....	1248	....	936	....	749
4 1/2	5.000	.355	....	7100	....	1420	....	1183	....	888	....	710
5	5.563	.375	....	6741	....	1348	....	1124	....	843	....	674
6	6.625	.432	....	6521	....	1304	....	1087	....	815	....	652
7	7.625	.500	....	6557	....	1311	....	1093	....	820	....	656
8	8.625	.500	....	5797	....	1159	....	966	....	725	....	580
9	9.625	.500	....	5195	....	1039	....	866	....	649	....	519
10	10.750	.500	....	4651	....	930	....	775	....	581	....	465
11	11.750	.500	....	4255	....	851	....	709	....	532	....	426
12	12.750	.500	....	3922	....	784	....	654	....	490	....	392
13	14.000	.500	....	3571	....	714	....	595	....	446	....	357
14	15.000	.500	....	3333	....	667	....	556	....	417	....	333
15	16.000	.500	....	3125	....	625	....	521	....	391	....	313

This information supplements that on pages 222 to 226

Internal Fluid Pressures for Double Extra Strong Pipe

Based on Barlow's formula $P = 2f\frac{t}{D}$

D = Outside diameter in inches.
t = Thickness of wall in inches.
P = Pressure in pounds per square inch.
f = Fiber stress in pounds per square inch.

Size	External diameter	Thickness	Ultimate bursting pressure		Pressures at various factors of safety							
			Butt-weld	Lap-weld	Factor of safety = 5		Factor of safety = 6		Factor of safety = 8		Factor of safety = 10	
			Fiber stress 40,000 lbs. per sq. in.	Fiber stress 50,000 lbs. per sq. in.	Butt-weld fiber stress =8000 lbs. per sq. in.	Lap weld fiber stress =10000 lbs. per sq. in.	Butt weld fiber stress =6667 lbs. per sq. in.	Lap weld fiber stress =8333 lbs. per sq. in.	Butt weld fiber stress =5000 lbs. per sq. in.	Lap weld fiber stress =6250 lbs. per sq. in.	Butt weld fiber stress =4000 lbs. per sq. in.	Lap weld fiber stress =5000 lbs. per sq. in.
½	.840	.294	28000	....	5600	....	4667	....	3500	....	2800	....
¾	1.050	.308	23467	....	4693	....	3911	....	2933	....	2347	....
1	1.315	.358	21779	....	4356	....	3630	....	2722	....	2178	....
1¼	1.660	.382	18410	....	3682	....	3068	....	2301	....	1841	....
1½	1.900	.400	16842	21053	3368	4211	2807	3509	2105	2632	1684	2105
2	2.375	.436	14686	18358	2937	3672	2448	3060	1836	2295	1469	1836
2½	2.875	.552	15360	19200	3072	3840	2560	3200	1920	2400	1536	1920
3	3.500	.600	....	17143	....	3429	....	2857	....	2143	....	1714
3½	4.000	.636	....	15900	....	3180	....	2650	....	1988	....	1590
4	4.500	.674	....	14978	....	2996	....	2496	....	1872	....	1498
4½	5.000	.710	....	14200	....	2840	....	2367	....	1775	....	1420
5	5.563	.750	....	13482	....	2696	....	2247	....	1685	....	1348
6	6.625	.864	....	13042	....	2608	....	2174	....	1630	....	1304
7	7.625	.875	....	11475	....	2295	....	1913	....	1434	....	1148
8	8.625	.875	....	10145	....	2029	....	1691	....	1268	....	1014

This information supplements that on pages [illegible] to [illegible]

Internal Fluid Pressures for Standard Boiler Tubes and Flues—Lap-Welded

Based on Barlow's Formula $P = 2f\dfrac{t}{D}$

D = Outside diameter in inches.
t = Thickness of wall in inches.
P = Pressure in pounds per square inch.
f = Fiber stress in pounds per square inch.

External diameter	Thickness		Ultimate bursting pressure	Pressures at various factors of safety			
				Factor of safety = 5	Factor of safety = 6	Factor of safety = 8	Factor of safety = 10
	Inches	B. W. G.	Fiber stress = 50,000 lbs. per sq. in.	Fiber stress = 10,000 lbs. per sq. in.	Fiber stress = 8333 lbs. per sq. in.	Fiber stress = 6250 lbs. per sq. in.	Fiber stress = 5000 lbs. per sq. in.
1¼	.095	13	5429	1086	905	679	543
2	.095	13	4750	950	792	594	475
2¼	.095	13	4222	844	704	528	422
2½	.109	12	4360	872	727	545	436
2¾	.109	12	3964	793	661	495	396
3	.109	12	3633	727	606	454	363
3¼	.120	11	3692	738	615	462	369
3½	.120	11	3429	686	571	429	343
3¾	.120	11	3206	640	533	400	320
4	.134	10	3350	670	558	419	335
4½	.134	10	2978	596	496	372	298
5	.148	9	2960	592	493	370	296
6	.165	8	2750	550	458	344	275
7	.165	8	2357	471	393	295	236
8	.165	8	2063	413	344	258	206
9	.180	7	2000	400	333	250	200
10	.203	6	2030	406	338	254	203
11	.220	5	2000	400	333	250	200
12	.229	......	1908	382	318	239	191
13	.238	4	1831	366	305	229	183
14	.248	......	1771	354	295	221	177
15	.259	3	1727	345	288	216	173
16	.270		1688	338	281	211	169

PURIFICATION OF BOILER WATER

The introduction to an article by P. M. LaBach* in Railway Master Mechanic, May, 1914, on "Purification of Water for Locomotives" forms a good preface to a study of boiler water, and is quoted below. A study of the whole article, which space will not permit of reprinting here, will well repay the reader:

"Scientific investigation tells us that pure water practically does not exist in nature. Snow and rain water in falling absorb the gaseous substances in the air. These are usually carbonic acid, nitric acid, and ammonia. In addition to this, water is a weakly oxidizing agent itself. Some of the impurities, such as carbonic acid, aid in dissolving a number of substances which are found in ordinary soil. A further addition of carbonic acid to surface water on its way into the earth is made by absorbing decaying vegetable matter. Having acquired acid properties, the water readily absorbs various mineral substances which are found in ordinary soils, including salts of lime and magnesia. When once dissolved, these substances are colorless as a rule, and do not make their presence known. Custom has given the term 'hardness' to the amount of salts in solution and we have 'total hardness,' 'temporary hardness,' etc., now used as technical terms. Table I shows the maximum amounts of different mineral substances which may be dissolved in pure water. These substances are found in varying quantities in nearly all water except that caught immediately upon falling.

TABLE I—SOLUBILITY IN 1 U. S. GALLON AT 60° F.

Calcium carbonate, $CaCO_3$	2.1 grains
Calcium chloride, $CaCl_2$	33.3 lbs.
Calcium sulphate, $CaSO_4$	134.1 grains
Magnesium carbonate, $MgCO_3$	Doubtful
Magnesium chloride, $MgCl_2$	16.6 lbs.
Magnesium sulphate, $MgSO_4$	2.5 lbs.
Sodium carbonate, Na_2CO_3	1.0 lb.
Sodium chloride, NaCl	2.9 lbs.
Sodium sulphate, Na_2SO_4	0.9 lb.

"As the solutions in the table are for ordinary temperatures, it is apparent that when present in the earth of the neighborhood or in the rocks underneath the surface, that any supply of water taken from a well or running stream is apt to contain impurities in liberal quantities.

"Rocks are worn away by the mechanical action of heat and freezing and are first oxidized, either by the oxygen of the air or by water. After this the hydrates of these substances are formed and solutions are made. In addition, there are a number of solutions of acids which may be either organic or inorganic in origin. These, in combination, form new substances which are soluble in water. The older chemists use the terms temporary and permanent hardness in referring to these compounds. Temporary hardness was understood to be the difference between the total

*Ass't Engineer, C. R. I. & P. Ry, Member A. S. C. E. and A. R. E. A.

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hardness and permanent hardness, while permanent hardness was that portion not precipitated by boiling. The effect of boiling is to drive off the carbon dioxide and precipitate the carbonates. In a great many of the reports, however, only the total hardness is given. The different units and their method of calculation properly belong to unabridged editions of books on this subject, but for reference the standard units are found in Table II.

TABLE II—STANDARDS OF HARDNESS

"German: One degree of hardness is the solution of one (1) part calcium oxide (CaO) in 100,000 parts of water, or .01 gram in one litre.

"French: One degree of hardness is the solution of one (1) part calcium carbonate ($CaCO_3$) in 100,000 parts of water, or .01 gram in one litre.

"English: One grain of calcium carbonate per 'Imperial' gallon of 70,000 grains.

"American: One grain of calcium carbonate per 'U. S.' gallon of 58,381 grains.

"The American and English standards are in the same unit as the French, $CaCO_3$ and in the proportion 58,381:70,000:100,000. One degree of French standard for hardness equals 1.79 degrees of the German.

"One degree of French standard for hardness equals 1.79 degiees of the German.

"There are innumerable substances found in water polluted by sewage and mill-waste, but each forms a separate problem and no general rules can be applied.

"The impurities found in water may be classified thus:

"I. Suspended matter:

- (a) Organic matter,
  1. Animal matter,
  2. Vegetable matter,
  3. Micro-organisms,
  4. Algae.
- (b) Inorganic matter:
  1. Mineral matter,
  2. Mineral oils,
  3. Clay,
  4. Sand,
  5. Silt.

} Removed by Mechanical Filtration.

"II. Dissolved substances:

- (a) Gases,
  1. Oxygen,
  2. Carbon dioxide,
  3. Chlorine,
  4. Hydrogen sulphide.
  5. Ammonia.
- (b) Solids
  1. Organic,
  2. Inorganic.

} Removed by heating or precipitated by chemical reagents.

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"Boiler waters are usually divided into four classes, when reference is made to the soluble impurities which cause trouble when in solution, these impurities being (1) Incrusting solids, (2) Inert subtances, (3) Corrosion substances, (4) Substances causing priming and foaming.

"Incrusting solids are those which form a coating or scale in the interior of the boiler through the action of either the heat or pressure. They are usually of two kinds, those forming hard scale or those forming soft scale.

"Inert substances are those which are harmless and have no action in the boiler. Their only effect is to raise the temperature of the boiling point. (3) and (4) are usually called non incrusting substances. They are defined as follows:

"A corrosive substance is one which causes deterioration of the steel of the boiler either by chemical or electrolytic action.

" 'A boiler is said to prime when water is carried as steam-bubbles, with the steam up through the water to its surface, and may be considered as affecting the entire depth of the water in a boiler.'

" 'Foaming is the result of suspended impurities in the water which, rise to its surface in a more or less dirty condition and form a scum. Pure water cannot produce foam; steam from a boiler which foams is dryer than that from a boiler which primes.' "

If serious trouble is apprehended on account of scale and deposits in the water, and this water is the best available in that locality, the services of a chemist experienced in investigating water troubles should be engaged. Most of the large water purification companies have well equipped laboratories and experts. It would be well to get the opinion of two or three experienced concerns making a specialty of boiler water treatment where there is much at stake and the water is of doubtful quality.

A water which is ideal in respect to incrusting foreign matter may be very corrosive. Should serious pitting of the tubes develop, it would be well to keep in mind that this is often a very complicated problem. Tubes may now be obtained which are as uniform as steel can be made and yet under certain conditions local corrosion or pitting will take place. The following suggestions may be used as a guide in tracing the causes of such trouble.

I. Note whether the pitting is scattered or confined to certain portions of the tube. Have the metal analyzed and examined on polished cross sections as to its uniformity. (National Tube Company maintains a well equipped laboratory for making such investigations. This service is free of charge to all users of "NATIONAL" products.)

II. In some waters, homogeneous metal will be pitted on account of the electrical potential difference between the mill scale on the surface and the metal underneath. The action will be stronger

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the more electrolytic the water is, depending on the presence of certain soluble salts.

A good plan in such cases is to remove the mill scale by pickling in dilute sulphuric acid and thoroughly washing the surface finally in lime water before inserting the tubes into the boiler. This will usually lessen the pitting considerably but may not be necessary if other precautions referred to below are followed out.

III. See to the feed water heater—*oxygen and carbonic acid in solution are the most frequent causes of corrosion.* The action of these gases is not direct, but it is nevertheless essential to continued corrosion that oxygen be present. For this reason *open feed water heaters* are preferable and should be well vented and run regularly at a temperature of 175° F. or higher.

IV. If the foregoing conditions have been complied with as far as possible, and you still have trouble it is time to call in a boiler water expert to advise on water treatment. The water should be maintained slightly alkaline but it is important that the alkalinity be controlled within certain limits. The water treatment necessary for removing scale forming matter will usually eliminate or at least lessen corrosion. The experience of railroads and others who have put in water softening plants is practically unanimous on this point.

In conclusion, remember that—

"A steam-boiler is a steam-generator, not a place for chemical reactions."

"The only 'compound' to put into a boiler is clean and soft water. Avoid quack remedies."

"Oxygen, when free in boilers, is a most destructive element."

For further study of this subject we refer you to Wm. W. Christie's work on "Boiler Waters" (D. Van Nostrand Company, New York City).

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KUTTER'S FORMULA

This formula now reads

S = slope = head + length,

measured in a straight line from end to end.

This formula should be changed to read

S = slope = head ÷ length.

Loss of Head in Pipe by Friction
Based on Cox's Formula (see page 289)

v = Velocity in feet per second.
H = Loss of head by friction in feet per 100 foot length of pipe.
Q = Discharge in cubic feet per minute.

	Inside diameter of pipe in inches											
v	4		5		6		7		8		9	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1.0	.146	5.2	.117	8.2	.097	11.8	.083	16.0	.073	20.9	.065	26.5
1.2	.203	6.3	.163	9.8	.136	14.1	.116	19.2	.102	25.1	.090	31.8
1.4	.268	7.3	.214	11.5	.178	16.5	.153	22.4	.134	29.3	.119	37.1
1.6	.338	8.4	.271	13.1	.226	18.8	.193	25.7	.169	33.5	.150	42.4
1.8	.416	9.4	.333	14.7	.277	21.2	.238	28.9	.208	37.7	.185	47.7
2.0	.500	10.5	.400	16.4	.333	23.6	.286	32.1	.250	41.9	.222	53.0
2.2	.591	11.5	.473	18.0	.394	25.9	.338	35.3	.295	46.1	.263	58.3
2.4	.688	12.6	.551	19.6	.459	28.8	.393	38.5	.344	50.3	.306	63.6
2.6	.793	13.6	.634	21.3	.528	30.6	.453	41.7	.396	54.5	.352	68.9
2.8	.903	14.7	.723	22.9	.602	33.0	.516	44.9	.452	58.6	.401	74.2
3.0	1.021	15.7	.817	24.5	.681	35.3	.583	48.1	.510	62.8	.454	79.5
3.2	1.145	16.8	.916	26.2	.763	37.7	.654	51.3	.573	67.0	.509	84.8
3.4	1.276	17.8	1.021	27.8	.851	40.1	.729	54.5	.638	71.2	.567	90.1
3.6	1.413	18.8	1.131	29.5	.942	42.4	.808	57.7	.707	75.4	.628	95.4
3.8	1.558	19.9	1.246	31.1	1.038	44.8	.890	60.9	.779	79.6	.692	101.
4.0	1.708	20.9	1.367	32.7	1.139	47.1	.976	64.1	.854	83.8	.750	106.
4.2	1.866	22.0	1.493	34.4	1.244	49.5	1.066	67.3	.933	88.0	.829	111.
4.4	2.030	23.0	1.624	36.0	1.353	51.8	1.160	70.6	1.015	92.2	.902	117.
4.6	2.201	24.1	1.761	37.6	1.467	54.2	1.258	73.8	1.100	96.3	.978	122.
4.8	2.378	25.1	1.903	39.3	1.586	56.5	1.359	77.0	1.189	101.	1.057	127.
5.0	2.563	26.2	2.050	40.9	1.708	58.9	1.464	80.2	1.281	105.	1.139	133.
5.2	2.753	27.2	2.203	42.5	1.836	61.3	1.573	83.4	1.377	109.	1.224	138.
5.4	2.951	28.3	2.361	44.2	1.967	63.6	1.686	86.6	1.475	113.	1.311	143.
5.6	3.155	29.3	2.524	45.8	2.103	66.0	1.803	90.0	1.578	117.	1.402	148.
5.8	3.366	30.4	2.693	47.5	2.244	68.3	1.925	93.0	1.683	121.	1.496	154.
6.0	3.583	31.4	2.867	49.1	2.389	70.7	2.048	96.2	1.792	126.	1.593	159.
6.5	4.156	34.0	3.325	53.2	2.771	76.6	2.375	104.	2.078	136.	1.847	172.
7.0	4.771	36.7	3.817	57.3	3.181	82.5	2.726	112.	2.385	147.	2.120	186.
7.5	5.427	39.3	4.342	61.4	3.618	88.4	3.101	120.	2.714	157.	2.412	199.
8.0	6.125	41.9	4.900	65.4	4.083	94.2	3.500	128.	3.063	168.	2.722	212.
8.5	6.865	44.5	5.492	69.5	4.576	100.	3.923	136.	3.432	178.	3.051	225.
9.0	7.646	47.1	6.117	73.6	5.097	106.	4.369	144.	3.823	188.	3.398	239.
9.5	8.469	49.7	6.775	77.7	5.646	112.	4.839	152.	4.234	199.	3.764	252.
10.0	9.333	52.4	7.467	81.8	6.222	118.	5.333	160.	4.667	209.	4.148	265.

This information replaces that on pages 286 to 288

Loss of Head in Pipe by Friction (Continued)
Based on Cox's Formula (**see page 289****)**

v = Velocity in feet per second.
H = Loss of head by friction in feet per 100 foot length of pipe.
Q = Discharge in cubic feet per minute.

v	Inside diameter of pipe in inches											
	10		11		12		13		14		15	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1.0	.058	32.7	.053	39.6	.049	47.1	.045	55.3	.042	64.1	.039	73.6
1.2	.081	39.3	.074	47.5	.068	56.5	.063	66.4	.058	77.0	.054	88.4
1.4	.107	45.8	.097	55.4	.089	66.0	.082	77.4	.076	89.8	.071	103.
1.6	.135	52.4	.123	63.4	.113	75.4	.104	88.5	.097	103.	.090	118.
1.8	.166	58.9	.151	71.3	.139	84.8	.128	99.5	.119	115.	.111	133.
2.0	.200	65.4	.182	79.2	.167	94.2	.154	111.	.143	128.	.133	147.
2.2	.236	72.0	.215	87.1	.197	104.	.182	122.	.169	141.	.158	162.
2.4	.275	78.5	.250	95.0	.229	113.	.212	133.	.197	154.	.184	177.
2.6	.317	85.1	.288	103.	.264	123.	.244	144.	.226	167.	.211	191.
2.8	.361	91.6	.328	111.	.301	132.	.278	155.	.258	180.	.241	206.
3.0	.408	98.2	.371	119.	.340	141.	.314	166.	.292	192.	.272	221.
3.2	.458	105.	.416	127.	.382	151.	.352	177.	.327	205.	.305	236.
3.4	.510	111.	.464	135.	.425	160.	.393	188.	.365	218.	.340	250.
3.6	.565	118.	.514	143.	.471	170.	.435	199.	.404	231.	.377	265.
3.8	.623	124.	.566	150.	.519	179.	.479	210.	.445	244.	.415	280.
4.0	.683	131.	.621	158.	.569	188.	.526	221.	.488	257.	.456	295.
4.2	.746	137.	.678	166.	.622	198.	.574	232.	.533	269.	.498	309.
4.4	.812	144.	.738	174.	.677	207.	.625	243.	.580	282.	.541	324.
4.6	.880	151.	.800	182.	.734	217.	.677	254.	.629	295.	.587	339.
4.8	.951	157.	.865	190.	.793	226.	.732	265.	.680	308.	.634	353.
5.0	1.025	164.	.932	198.	.854	236.	.788	277.	.732	321.	.683	368.
5.2	1.101	170.	1.001	206.	.918	245.	.847	288.	.787	334.	.734	383.
5.4	1.180	177.	1.073	214.	.984	254.	.908	299.	.843	346.	.787	398.
5.6	1.262	183.	1.147	222.	1.052	264.	.971	310.	.901	359.	.841	412.
5.8	1.346	190.	1.224	230.	1.122	273.	1.036	321.	.962	372.	.898	427.
6.0	1.433	196.	1.303	238.	1.194	283.	1.103	332.	1.024	385.	.956	442.
6.5	1.663	213.	1.511	257.	1.385	306.	1.279	359.	1.188	417.	1.108	470.
7.0	1.908	229.	1.735	277.	1.590	330.	1.468	387.	1.363	449.	1.272	515.
7.5	2.171	245.	1.973	297.	1.809	353.	1.670	415.	1.551	481.	1.447	552.
8.0	2.450	262.	2.227	317.	2.042	377.	1.885	442.	1.750	513.	1.633	589.
8.5	2.746	278.	2.496	337.	2.288	401.	2.112	470.	1.961	545.	1.831	626.
9.0	3.058	295.	2.780	356.	2.549	424.	2.353	498.	2.185	577.	2.039	663.
9.5	3.388	311.	3.080	376.	2.823	448.	2.606	525.	2.420	609.	2.258	699.
10.0	3.733	327.	3.394	396.	3.111	471.	2.872	553.	2.667	641.	2.489	736.

'his information replaces that on pages 286 to 288

Loss of Head in Pipe by Friction (Continued)
Based on Cox's Formula (see page 280)

v = Velocity in feet per second.
H = Loss of head by friction in feet per 100 foot length of pipe.
Q = Discharge in cubic feet per minute.

v	Inside diameter of pipe in inches											
	16		17		18		19		20		21	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1.0	.036	83.8	.034	94.6	.032	106.	.031	118.	.029	131.	.028	144.
1.2	.051	101.	.048	113.	.045	127.	.043	142.	.041	157.	.039	178.
1.4	.067	117.	.063	132.	.059	148.	.056	165.	.054	183.	.051	202.
1.6	.085	134.	.080	151.	.075	170.	.071	189.	.068	209.	.064	231.
1.8	.104	151.	.098	170.	.092	191.	.088	213.	.083	236.	.079	260.
2.0	.125	168.	.118	189.	.111	212.	.105	236.	.100	262.	.095	289.
2.2	.148	184.	.139	208.	.131	233.	.124	260.	.118	288.	.113	317.
2.4	.172	201.	.162	227.	.153	254.	.145	284.	.138	314.	.131	346.
2.6	.198	218.	.186	246.	.176	276.	.167	307.	.159	340.	.151	375.
2.8	.226	235.	.213	265.	.201	297.	.190	331.	.181	367.	.172	404.
3.0	.255	251.	.240	284.	.227	318.	.215	354.	.204	393.	.194	433.
3.2	.286	268.	.269	303.	.254	339.	.241	378.	.229	419.	.218	462.
3.4	.319	285.	.300	322.	.284	360.	.269	402.	.255	445.	.243	491.
3.6	.353	302.	.333	340.	.314	382.	.298	425.	.283	471.	.269	520.
3.8	.389	318.	.366	359.	.346	403.	.328	449.	.312	497.	.297	548.
4.0	.427	335.	.402	378.	.380	424.	.360	473.	.342	524.	.325	577.
4.2	.466	352.	.439	397.	.415	445.	.393	496.	.373	550.	.355	606.
4.4	.508	369.	.478	416.	.451	467.	.427	520.	.406	576.	.387	635.
4.6	.550	385.	.518	435.	.489	488.	.463	543.	.440	602.	.419	664.
4.8	.595	402.	.560	454.	.529	509.	.501	567.	.476	628.	.453	693.
5.0	.641	419.	.603	473.	.569	530.	.539	591.	.513	654.	.488	722.
5.2	.688	436.	.648	492.	.612	551.	.580	614.	.551	681.	.524	750.
5.4	.738	452.	.694	511.	.656	573.	.621	638.	.590	707.	.562	779.
5.6	.789	469.	.742	530.	.701	594.	.664	662.	.631	733.	.601	808.
5.8	.841	486.	.792	549.	.748	615.	.709	685.	.673	759.	.641	837.
6.0	.896	503.	.843	567.	.796	636.	.754	709.	.717	785.	.683	866.
6.5	1.039	545.	.978	615.	.924	689.	.875	768.	.831	851.	.792	938.
7.0	1.193	586.	1.123	662.	1.060	742.	1.004	827.	.954	916.	.909	1010.
7.5	1.357	628.	1.277	709.	1.206	795.	1.143	886.	1.085	982.	1.034	1082.
8.0	1.531	670.	1.441	757.	1.361	848.	1.289	945.	1.225	1047.	1.167	1155.
8.5	1.716	712.	1.615	804.	1.525	901.	1.445	1004.	1.373	1113.	1.308	1227.
9.0	1.911	754.	1.799	851.	1.699	954.	1.610	1063.	1.529	1178.	1.456	1299.
9.5	2.117	796.	1.993	898.	1.882	1007.	1.783	1122.	1.694	1244.	1.613	1371.
10.0	2.333	838.	2.196	946.	2.074	1060.	1.965	1181.	1.867	1309.	1.778	1443.

This information replaces that on pages 286 to 288

Loss of Head in Pipe by Friction (Continued)
Based on Cox's Formula **(see page 280)**

v = Velocity in feet per second.
H = Loss of head by friction in feet per 100 foot length of pipe.
Q = Discharge in cubic feet per minute.

v	Inside diameter of pipe in inches											
	10		11		12		13		14		15	
	H	*Q*	*H*	*Q*	*H*	*Q*	*H*	*Q*	*H*	*Q*	*H*	*Q*
1.0	.058	32.7	.053	39.6	.049	47.1	.045	55.3	.042	64.1	.039	73.6
1.2	.081	39.3	.074	47.5	.068	56.5	.063	66.4	.058	77.0	.054	88.4
1.4	.107	45.8	.097	55.4	.089	66.0	.082	77.4	.076	89.8	.071	103.
1.6	.135	52.4	.123	63.4	.113	75.4	.104	88.5	.097	103.	.090	118.
1.8	.166	58.9	.151	71.3	.139	84.8	.128	99.5	.119	115.	.111	133.
2.0	.200	65.4	.182	79.2	.167	94.2	.154	111.	.143	128.	.133	147.
2.2	.236	72.0	.215	87.1	.197	104.	.182	122.	.169	141.	.158	162.
2.4	.275	78.5	.250	95.0	.229	113.	.212	133.	.197	154.	.184	177.
2.6	.317	85.1	.288	103.	.264	123.	.244	144.	.226	167.	.211	191.
2.8	.361	91.6	.328	111.	.301	132.	.278	155.	.258	180.	.241	206.
3.0	.408	98.2	.371	119.	.340	141.	.314	166.	.292	192.	.272	221.
3.2	.458	105.	.416	127.	.382	151.	.352	177.	.327	205.	.305	236.
3.4	.510	111.	.464	135.	.425	160.	.393	188.	.365	218.	.340	250.
3.6	.565	118.	.514	143.	.471	170.	.435	199.	.404	231.	.377	265.
3.8	.623	124.	.566	150.	.519	179.	.479	210.	.445	244.	.415	280.
4.0	.683	131.	.621	158.	.569	188.	.526	221.	.488	257.	.456	295.
4.2	.746	137.	.678	166.	.622	198.	.574	232.	.533	269.	.498	309.
4.4	.812	144.	.738	174.	.677	207.	.625	243.	.580	282.	.541	324.
4.6	.880	151.	.800	182.	.734	217.	.677	254.	.629	295.	.587	339.
4.8	.951	157.	.865	190.	.793	226.	.732	265.	.680	308.	.634	353.
5.0	1.025	164.	.932	198.	.854	236.	.788	277.	.732	321.	.683	368.
5.2	1.101	170.	1.001	206.	.918	245.	.847	288.	.787	334.	.734	383.
5.4	1.180	177.	1.073	214.	.984	254.	.908	299.	.843	346.	.787	398.
5.6	1.262	183.	1.147	222.	1.052	264.	.971	310.	.901	359.	.841	412.
5.8	1.346	190.	1.224	230.	1.122	273.	1.036	321.	.962	372.	.898	427.
6.0	1.433	196.	1.303	238.	1.194	283.	1.103	332.	1.024	385.	.956	442.
6.5	1.663	213.	1.511	257.	1.385	306.	1.279	359.	1.188	417.	1.108	470.
7.0	1.908	229.	1.735	277.	1.590	330.	1.468	387.	1.363	449.	1.272	515.
7.5	2.171	245.	1.973	297.	1.809	353.	1.670	415.	1.551	481.	1.447	552.
8.0	2.450	262.	2.227	317.	2.042	377.	1.885	442.	1.750	513.	1.633	589.
8.5	2.746	278.	2.496	337.	2.288	401.	2.112	470.	1.961	545.	1.831	626.
9.0	3.058	295.	2.780	356.	2.549	424.	2.353	498.	2.185	577.	2.039	663.
9.5	3.388	311.	3.080	376.	2.823	448.	2.606	525.	2.420	609.	2.258	699.
10.0	3.733	327.	3.394	396.	3.111	471.	2.872	553.	2.667	641.	2.489	736.

'his information replaces that on pages 286 to 288

Loss of Head in Pipe by Friction (Continued)
Based on Cox's Formula (see page 286)

v = Velocity in feet per second.
H = Loss of head by friction in feet per 100 foot length of pipe.
Q = Discharge in cubic feet per minute.

v	Inside diameter of pipe in inches											
	16		17		18		19		20		21	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1.0	.036	83.8	.034	94.6	.032	106.	.031	118.	.029	131.	.028	144.
1.2	.051	101.	.048	113.	.045	127.	.043	142.	.041	157.	.039	178.
1.4	.067	117.	.063	132.	.059	148.	.056	165.	.054	183.	.051	202.
1.6	.085	134.	.080	151.	.075	170.	.071	189.	.068	209.	.064	231.
1.8	.104	151.	.098	170.	.092	191.	.088	213.	.083	236.	.079	260.
2.0	.125	168.	.118	189.	.111	212.	.105	236.	.100	262.	.095	289.
2.2	.148	184.	.139	208.	.131	233.	.124	260.	.118	288.	.113	317.
2.4	.172	201.	.162	227.	.153	254.	.145	284.	.138	314.	.131	346.
2.6	.198	218.	.186	246.	.176	276.	.167	307.	.159	340.	.151	375.
2.8	.226	235.	.213	265.	.201	297.	.190	331.	.181	367.	.172	404.
3.0	.255	251.	.240	284.	.227	318.	.215	354.	.204	393.	.194	433.
3.2	.286	268.	.269	303.	.254	339.	.241	378.	.229	419.	.218	462.
3.4	.319	285.	.300	322.	.284	360.	.269	402.	.255	445.	.243	491.
3.6	.353	302.	.333	340.	.314	382.	.298	425.	.283	471.	.269	520.
3.8	.389	318.	.366	359.	.346	403.	.328	449.	.312	497.	.297	548.
4.0	.427	335.	.402	378.	.380	424.	.360	473.	.342	524.	.325	577.
4.2	.466	352.	.439	397.	.415	445.	.393	496.	.373	550.	.355	606.
4.4	.508	369.	.478	416.	.451	467.	.427	520.	.406	576.	.387	635.
4.6	.550	385.	.518	435.	.489	488.	.463	543.	.440	602.	.419	664.
4.8	.595	402.	.560	454.	.529	509.	.501	567.	.476	628.	.453	693.
5.0	.641	419.	.603	473.	.569	530.	.539	591.	.513	654.	.488	722.
5.2	.688	436.	.648	492.	.612	551.	.580	614.	.551	681.	.524	750.
5.4	.738	452.	.694	511.	.656	573.	.621	638.	.590	707.	.562	779.
5.6	.789	469.	.742	530.	.701	594.	.664	662.	.631	733.	.601	808.
5.8	.841	486.	.792	549.	.748	615.	.709	685.	.673	759.	.641	837.
6.0	.896	503.	.843	567.	.796	636.	.754	709.	.717	785.	.683	866.
6.5	1.039	545.	.978	615.	.924	689.	.875	768.	.831	851.	.792	938.
7.0	1.193	586.	1.123	662.	1.060	742.	1.004	827.	.954	916.	.909	1010.
7.5	1.357	628.	1.277	709.	1.206	795.	1.143	886.	1.085	982.	1.034	1082.
8.0	1.531	670.	1.441	757.	1.361	848.	1.289	945.	1.225	1047.	1.167	1155.
8.5	1.716	712.	1.615	804.	1.525	901.	1.445	1004.	1.373	1113.	1.308	1227.
9.0	1.911	754.	1.799	851.	1.699	954.	1.610	1063.	1.529	1178.	1.456	1299.
9.5	2.117	796.	1.993	898.	1.882	1007.	1.783	1122.	1.694	1244.	1.613	1371.
10.0	2.338	838.	2.196	946.	2.074	1060.	1.965	1181.	1.867	1309.	1.778	1443.

This information replaces that on pages 286 to 288

Loss of Head in Pipe by Friction (Continued)
Based on Cox's Formula (see page 289)

v = Velocity in feet per second.
H = Loss of head by friction in feet per 100 foot length of pipe.
Q = Discharge in cubic feet per minute.

v	Inside diameter of pipe in inches											
	22		24		26		28		30		33	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1.0	.027	158.	.024	188.	.022	221.	.021	257.	.019	295.	.018	356.
1.2	.037	190.	.034	226.	.031	265.	.029	308.	.027	353.	.025	428.
1.4	.049	222.	.045	264.	.041	310.	.038	359.	.036	412.	.032	499.
1.6	.062	253.	.056	302.	.052	354.	.048	411.	.045	471.	.041	570.
1.8	.076	285.	.069	339.	.064	398.	.059	462.	.055	530.	.050	641.
2.0	.091	317.	.083	377.	.077	442.	.071	513.	.067	589.	.061	713.
2.2	.107	348.	.098	415.	.091	487.	.084	564.	.079	648.	.072	784.
2.4	.125	380.	.115	452.	.106	531.	.098	616.	.092	707.	.083	855.
2.6	.144	412.	.132	490.	.122	575.	.113	667.	.106	766.	.096	927.
2.8	.164	443.	.151	528.	.139	619.	.129	718.	.120	825.	.109	998.
3.0	.186	475.	.170	565.	.157	664.	.146	770.	.136	884.	.124	1069.
3.2	.208	507.	.191	603.	.176	708.	.164	821.	.153	942.	.139	1140.
3.4	.232	539.	.213	641.	.196	752.	.182	872.	.170	1001.	.155	1212.
3.6	.257	570.	.236	679.	.217	796.	.202	924.	.188	1060.	.171	1283.
3.8	.283	602.	.260	716.	.240	841.	.223	975.	.208	1119.	.189	1354.
4.0	.311	634.	.285	754.	.263	885.	.244	1026.	.228	1178.	.207	1425.
4.2	.339	665.	.311	792.	.287	929.	.267	1078.	.249	1237.	.226	1497.
4.4	.369	697.	.338	829.	.312	973.	.290	1129.	.271	1296.	.246	1568.
4.6	.400	729.	.367	867.	.339	1018.	.314	1180.	.293	1355.	.267	1639.
4.8	.432	760.	.396	905.	.366	1062.	.340	1232.	.317	1414.	.288	1711.
5.0	.466	792.	.427	942.	.394	1106.	.366	1283.	.342	1473.	.311	1782.
5.2	.501	824.	.459	980.	.424	1150.	.393	1334.	.367	1532.	.334	1853.
5.4	.537	855.	.492	1018.	.454	1195.	.422	1385.	.393	1590.	.358	1924.
5.6	.574	887.	.526	1056.	.485	1239.	.451	1437.	.421	1649.	.382	1996.
5.8	.612	919.	.561	1093.	.518	1283.	.481	1488.	.449	1708.	.408	2067.
6.0	.652	950.	.597	1131.	.551	1327.	.512	1539.	.478	1767.	.434	2138.
6.5	.756	1030.	.693	1225.	.639	1438.	.594	1668.	.554	1914.	.504	2316.
7.0	.867	1109.	.795	1319.	.734	1549.	.682	1796.	.636	2062.	.578	2495.
7.5	.987	1188.	.905	1414.	.835	1659.	.775	1924.	.724	2209.	.658	2673.
8.0	1.114	1267.	1.021	1508.	.942	1770.	.875	2053.	.817	2356.	.742	2851.
8.5	1.248	1346.	1.144	1602.	1.056	1880.	.981	2181.	.915	2503.	.832	3029.
9.0	1.390	1425.	1.274	1696.	1.176	1991.	1.092	2309.	1.019	2651.	.927	3207.
9.5	1.540	1505.	1.411	1791.	1.303	2102.	1.210	2437.	1.129	2798.	1.027	3386.
10.0	1.697	1584.	1.556	1885.	1.436	2212.	1.333	2566.	1.244	2945.	1.131	3564.

his information replaces that on pages 888 to 888

Loss of Head in Pipe by Friction (Concluded)
Based on Cox's Formula (see page 289)

v = Velocity in feet per second.
H = Loss of head by friction in feet per 100 foot length of pipe.
Q = Discharge in cubic feet per minute.

v	Inside diameter of pipe in inches									
	36		39		42		45		48	
	H	Q	H	Q	H	Q	H	Q	H	Q
1.0	.016	424.	.015	498.	.014	577.	.013	663.	.012	754.
1.2	.023	509.	.021	597.	.019	693.	.018	795.	.017	905.
1.4	.030	594.	.027	697.	.025	808.	.024	928.	.022	1056.
1.6	.038	679.	.035	796.	.032	924.	.030	1060.	.028	1206.
1.8	.046	763.	.043	896.	.040	1039.	.037	1193.	.035	1357.
2.0	.056	848.	.051	995.	.048	1155.	.044	1325.	.041	1508.
2.2	.066	933.	.061	1095.	.056	1270.	.053	1458.	.049	1659.
2.4	.076	1018.	.071	1195.	.066	1385.	.061	1590.	.057	1810.
2.6	.088	1103.	.081	1294.	.075	1501.	.070	1723.	.066	1960.
2.8	.100	1188.	.093	1394.	.086	1616.	.080	1856.	.075	2111.
3.0	.113	1272.	.105	1493.	.097	1732.	.091	1988.	.085	2262.
3.2	.127	1357.	.117	1593.	.109	1847.	.102	2121.	.095	2413.
3.4	.142	1442.	.131	1692.	.122	1963.	.113	2253.	.106	2564.
3.6	.157	1527.	.145	1792.	.135	2078.	.126	2386.	.118	2714.
3.8	.173	1612.	.160	1891.	.148	2194.	.138	2518.	.130	2865.
4.0	.190	1696.	.175	1991.	.163	2309.	.152	2651.	.142	3016.
4.2	.207	1781.	.191	2091.	.178	2425.	.166	2783.	.155	3167.
4.4	.226	1866.	.208	2190.	.193	2540.	.180	2916.	.169	3318.
4.6	.245	1951.	.226	2290.	.210	2655.	.196	3048.	.183	3468.
4.8	.264	2036.	.244	2389.	.227	2771.	.211	3181.	.198	3619.
5.0	.285	2121.	.263	2489.	.244	2886.	.228	3313.	.214	3770.
5.2	.306	2205.	.282	2588.	.262	3002.	.245	3446.	.229	3921.
5.4	.328	2290.	.303	2688.	.281	3117.	.262	3578.	.246	4072.
5.6	.351	2375.	.324	2787.	.300	3233.	.280	3711.	.263	4222.
5.8	.374	2460.	.345	2887.	.321	3348.	.299	3844.	.280	4373.
6.0	.398	2545.	.368	2986.	.341	3464.	.319	3976.	.299	4524.
6.5	.462	2757.	.426	3235.	.396	3752.	.369	4307.	.346	4901.
7.0	.530	2969.	.489	3484.	.454	4041.	.424	4639.	.398	5278.
7.5	.603	3181.	.557	3733.	.517	4330.	.482	4970.	.452	5655.
8.0	.681	3393.	.628	3982.	.583	4618.	.544	5301.	.510	6032.
8.5	.763	3605.	.704	4231.	.654	4907.	.610	5633.	.572	6409.
9.0	.850	3817.	.784	4480.	.728	5195.	.680	5964.	.637	6786.
9.5	.941	4029.	.869	4729.	.807	5484.	.753	6295.	.706	7163.
10.0	1.037	4241.	.957	4977.	.889	5773.	.830	6627.	.778	7540.

This information replaces that on pages 286 to 288

Relative Discharging Capacities of Double Extra Strong Pipe

Relative Discharge Capacity = $\sqrt{\text{Inside Diameter}^5}$

Actual Internal Diameter	.252	.434	.599	.896	1.100	1.503	1.771
Nominal Internal Diameter	½	¾	1	1¼	1½	2	2½
½	1.000	....	....	....	....	....	....
¾	3.892	1.000	....	....	....	....	....
1	8.711	2.238	1.000	....	....	....	....
1¼	23.838	6.124	2.737	1.000	....	....	....
1½	39.809	10.227	4.570	1.670	1.000	....	....
2	86.875	22.319	9.973	3.644	2.182	1.000	....
2½	130.932	33.637	15.031	5.493	3.030	1.507	1.000
3	251.662	64.654	28.890	10.557	6.352	2.897	1.922
3½	385.576	99.057	44.236	16.175	9.686	4.438	2.945
4	553.304	142.148	63.518	23.211	13.899	6.369	4.226
4½	760.687	195.427	103.795	31.911	19.108	8.756	5.810
5	1043.796	268.157	119.826	43.787	26.220	12.015	7.972
6	1664.653	427.662	191.099	69.832	41.817	19.161	11.529
7	2624.329	674.210	301.268	110.057	65.923	30.208	20.043
8	3887.589	998.751	446.287	163.084	97.656	44.749	29.692

Actual Internal Diameter	2.300	2.728	3.152	3.580	4.063	4.897	5.875	6.875
Nominal Internal Diameter	3	3½	4	4½	5	6	7	8
3	1.000	......	......	......	......	......	......	......
3½	1.532	1.000	......	......	......	......	......	......
4	2.199	1.435	1.000	......	......	......	......	......
4½	3.023	1.973	1.375	1.000	......	......	......	......
5	4.148	2.707	1.886	1.372	1.000	......	......	......
6	6.615	4.317	3.009	1.993	1.523	1.000	......	......
7	10.428	6.806	4.390	3.450	2.474	1.577	1.000	......
8	15.448	10.083	7.026	5.111	3.724	2.335	1.481	1.000

his information supplements that on pages 306 to 309

***Quantity of Gas, Size of Feed Pipes, etc., Required for Gas Engines**

Table showing approximate discharge of gas of 0.6 specific gravity in 1 inch straight pipe, for various lengths, in cubic feet per hour, at the pressure of 4 oz. equal to 6.9 inches water at the intake and 3.7 oz. equal to 6.4 inches water at discharge end.

Length of pipe in feet	Cubic feet per hour	Length of pipe in feet	Cubic feet per hour	Length of pipe in feet	Cubic feet per hour
50	350	600	102	1600	62
100	247	700	95	1800	58
150	203	800	88	2000	55
200	175	900	83	2500	50
250	152	1000	76	3000	47
300	143	1100	73	3500	42
350	136	1200	71	4000	40
400	124	1300	68	4500	37
450	115	1400	66	5000	35
500	110	1500	64	5280	34

For sizes other than one-inch, use table below.

Multipliers for Diameters Other than One Inch

Size pipe, inches	½	1	1¼	1½	2	2½	3
Multipliers............	.181	1.00	1.80	2.93	5.92	10.60	16.50

Size pipe, inches	4	5	6	8	10	12	15
Multipliers............	34.10	60.0	95.0	198.0	350.0	556.0	863.0

Example: Suppose that a gas engine 400 feet away from the main line carrying 4 oz. pressure requires 350 cubic feet per hour, by inspection of the above table it will be found that one inch pipe under like conditions will deliver 124 cubic feet, 350 ÷ 124 = 2.80.

By inspection of the table it will be seen that 1½ inch is 2.93 greater in capacity than one inch and is, therefore, nearest to the required size.

Gas engines of the type used for pumping oil wells consume from twelve to thirteen cubic feet of gas per horse power per hour. Larger engines for commercial purposes require less gas, about nine to eleven cubic feet per horse power per hour.

Ten and one-half cubic feet of air are necessary for the combustion of one cubic foot of gas.

Comparison of Fuel per Horse Power per Hour for Gas, Gasoline and Steam Engines

	Gas at 25c per 1000 ft.		Gasoline at 15c per gallon		Coal at $2.50 per ton	
	Cubic feet	Cost in cents	Gallons	Cost in cents	Pounds	Cost in cents
Commercial gas engine	9	.225	1/12	1.25	....	....
Oil country style gas engine............	13	.325	1/10	1.5	....	....
Steam engine with cut off............	40	1.	....	....	4	.5
Steam engine without cut off............	80	2.	....	....	8	1
Oil country style steam engine............	130	3.25	....	....	13	1.63

*From page 602 catalog No. 20, National Supply Company, Pittsburgh, Pa., used with their permission.

This information supplements that on pages 314 to 325

Size	Diameter		Thickness	Circumference		Transverse area			Length of pipe per square foot		Length of pipe containing one cu. ft.
	External	Internal		External	Internal	External	Internal	Metal	External surface	Internal surface	
	Inches	Inches	Inches	Inches	Inches	Sq. in.	Sq. in.	Sq. in.	Feet	Feet	Feet
1/8	.405	.269	.068	1.272	.845	.129	.057	.072	9.431	14.199	2533.775
1/4	.540	.364	.088	1.696	1.144	.229	.104	.125	7.073	10.493	1383.789
3/8	.675	.493	.091	2.121	1.549	.358	.191	.167	5.658	7.747	754.360
1/2	.840	.622	.109	2.639	1.954	.554	.304	.250	4.547	6.141	473.906
3/4	1.050	.824	.113	3.299	2.589	.866	.533	.333	3.637	4.635	270.034
1	1.315	1.049	.133	4.131	3.296	1.358	.864	.494	2.904	3.641	166.618
1 1/4	1.660	1.380	.140	5.215	4.335	2.164	1.495	.669	2.301	2.767	96.275
1 1/2	1.900	1.610	.145	5.969	5.058	2.835	2.036	.799	2.010	2.372	70.733
2	2.375	2.067	.154	7.461	6.494	4.430	3.355	1.075	1.608	1.847	42.913
2 1/2	2.875	2.469	.203	9.032	7.757	6.492	4.788	1.704	1.328	1.547	30.077
3	3.500	3.068	.216	10.996	9.638	9.621	7.393	2.228	1.091	1.245	19.479
3 1/2	4.000	3.548	.226	12.566	11.146	12.566	9.886	2.680	.954	1.076	14.565
4	4.500	4.026	.237	14.137	12.648	15.904	12.730	3.174	.848	.948	11.312
4 1/2	5.000	4.506	.247	15.708	14.156	19.635	15.947	3.688	.763	.847	9.030
5	5.563	5.047	.258	17.477	15.856	24.306	20.006	4.300	.686	.756	7.198
6	6.625	6.065	.280	20.813	19.054	34.472	28.891	5.581	.576	.629	4.984
7	7.625	7.023	.301	23.955	22.063	45.664	38.738	6.926	.500	.543	3.717
8	8.625	8.071	.277	27.096	25.356	58.426	51.161	7.265	.442	.473	2.815
8	8.625	7.981	.322	27.096	25.073	58.426	50.027	8.399	.442	.478	2.878
9	9.625	8.941	.342	30.238	28.089	72.760	62.786	9.974	.396	.427	2.294
10	10.750	10.192	.279	33.772	32.019	90.763	81.585	9.178	.355	.374	1.765
10	10.750	10.136	.307	33.772	31.843	90.763	80.691	10.072	.355	.376	1.785
10	10.750	10.020	.365	33.772	31.479	90.763	78.855	11.908	.355	.381	1.826
11	11.750	11.000	.375	36.914	34.558	108.434	95.033	13.401	.325	.347	1.515
12	12.750	12.090	.330	40.055	37.982	127.676	114.800	12.876	.299	.315	1.254
12	12.750	12.000	.375	40.055	37.699	127.676	113.097	14.579	.299	.318	1.273
13	14.000	13.250	.375	43.982	41.626	153.938	137.886	16.052	.272	.288	1.044
14	15.000	14.250	.375	47.124	44.768	176.715	159.485	17.230	.254	.268	.903
15	16.000	15.250	.375	50.265	47.909	201.062	182.654	18.408	.238	.250	.788
17O.D.	17.000	16.214	.393	53.407	50.938	226.980	206.476	20.504	.224	.235	.697
18O.D.	18.000	17.182	.409	56.540	53.979	254.469	231.866	22.603	.212	.222	.681
20O.D.	20.000	19.182	.409	62.832	60.262	314.159	288.986	25.173	.190	.199	.408

information supplements that on pages 419 to 459

Circumferences, Transverse Areas and Surfaces for Extra Strong Pipe

Size	Diameter		Thickness	Circumference		Transverse area			Length of pipe per square foot		Length of pipe containing one cu. ft.
	External	Internal		External	Internal	External	Internal	Metal	External surface	Internal surface	
	Inches	Inches	Inches	Inches	Inches	Sq. in.	Sq. in.	Sq. in.	Feet	Feet	Feet
1/8	.405	.215	.095	1.272	.675	.129	.036	.093	9.431	17.766	3966.393
1/4	.540	.302	.119	1.696	.949	.229	.072	.157	7.073	12.648	2010.290
3/8	.675	.423	.126	2.121	1.329	.358	.141	.217	5.658	9.030	1024.689
1/2	.840	.546	.147	2.639	1.715	.554	.234	.320	4.547	6.995	615.017
3/4	1.050	.742	.154	3.299	2.331	.866	.433	.433	3.637	5.147	333.016
1	1.315	.957	.179	4.131	3.007	1.358	.719	.639	2.904	3.991	200.193
1 1/4	1.660	1.278	.191	5.215	4.015	2.164	1.283	.881	2.301	2.988	112.256
1 1/2	1.900	1.500	.200	5.969	4.712	2.835	1.767	1.068	2.010	2.546	81.487
2	2.375	1.939	.218	7.461	6.092	4.430	2.953	1.477	1.608	1.969	48.766
2 1/2	2.875	2.323	.276	9.032	7.298	6.492	4.238	2.254	1.328	1.644	33.976
3	3.500	2.900	.300	10.996	9.111	9.621	6.605	3.016	1.091	1.317	21.801
3 1/2	4.000	3.364	.318	12.566	10.568	12.566	8.888	3.678	.954	1.135	16.202
4	4.500	3.826	.337	14.137	12.020	15.904	11.497	4.407	.848	.998	12.525
4 1/2	5.000	4.290	.355	15.708	13.477	19.635	14.455	5.180	.763	.890	9.962
5	5.563	4.813	.375	17.477	15.120	24.306	18.194	6.112	.686	.793	7.915
6	6.625	5.761	.432	20.813	18.099	34.472	26.067	8.405	.576	.663	5.524
7	7.625	6.625	.500	23.955	20.813	45.664	34.472	11.192	.500	.576	4.177
8	8.625	7.625	.500	27.096	23.955	58.426	45.663	12.763	.442	.500	3.154
9	9.625	8.625	.500	30.238	27.096	72.760	58.426	14.334	.396	.442	2.465
10	10.750	9.750	.500	33.772	30.631	90.763	74.662	16.101	.355	.391	1.929
11	11.750	10.750	.500	36.914	33.772	108.434	90.763	17.671	.325	.355	1.587
12	12.750	11.750	.500	40.055	36.914	127.676	108.434	19.242	.299	.325	1.328
13	14.000	13.000	.500	43.982	40.841	153.938	132.732	21.266	.272	.293	1.085
14	15.000	14.000	.500	47.124	43.982	176.715	153.938	22.777	.254	.272	.935
15	16.000	15.000	.500	50.265	47.124	201.062	176.715	24.347	.238	.254	.815

This information supplements that on pages 419 to 459

Circumferences, Transverse Areas and Surfaces for Double Extra Strong Pipe

Size	Diameter		Thickness	Circumference		Transverse area			Length of pipe per square foot		Length of pipe containing one cu. ft.
	External	Internal		External	Internal	External	Internal	Metal	External surface	Internal surface	
	Inches	Inches	Inches	Inches	Inches	Sq. in.	Sq. in.	Sq. in.	Feet	Feet	Feet
½	.840	.252	.294	2.639	.792	.554	.050	.504	4.547	15.157	2887.165
¾	1.050	.434	.308	3.299	1.363	.866	.148	.718	3.637	8.801	973.404
1	1.315	.599	.358	4.131	1.882	1.358	.282	1.076	2.904	6.376	510.998
1¼	1.660	.896	.382	5.215	2.815	2.164	.630	1.534	2.301	4.263	228.379
1½	1.900	1.100	.400	5.969	3.456	2.835	.950	1.885	2.010	3.472	151.526
2	2.375	1.503	.436	7.461	4.722	4.430	1.774	2.656	1.608	2.541	81.162
2½	2.875	1.771	.552	9.032	5.564	6.492	2.464	4.028	1.328	2.156	58.457
3	3.500	2.300	.600	10.996	7.226	9.621	4.155	5.466	1.091	1.660	34.659
3½	4.000	2.728	.636	12.566	8.570	12.566	5.845	6.721	.954	1.400	24.637
4	4.500	3.152	.674	14.137	9.902	15.904	7.803	8.101	.848	1.211	18.454
4½	5.000	3.580	.710	15.708	11.247	19.635	10.066	9.569	.763	1.066	14.306
5	5.563	4.063	.750	17.477	12.764	24.306	12.966	11.340	.686	.940	11.107
6	6.625	4.897	.864	20.813	15.384	34.472	18.835	15.637	.576	.780	7.646
7	7.625	5.875	.875	23.955	18.457	45.664	27.109	18.555	.500	.650	5.312
8	8.625	6.875	.875	27.096	21.598	58.426	37.122	21.304	.442	.555	3.879

This information supplements that on pages 419 to 459

Circumferences, Transverse Areas and Surfaces for Standard Boiler Tubes and Flues

Diameter External	Diameter Internal	Thickness	Thickness	Circumference External	Circumference Internal	Transverse area External	Transverse area Internal	Transverse area Metal	Length of tube per square foot: External surface	Length of tube per square foot: Internal surface	Length of tube containing one cu. ft.
Inches	Inches	Inches	B. W. G.	Inches	Inches	Sq. in.	Sq. in.	Sq. in.	Feet	Feet	Feet
1¾	1.560	.095	13	5.498	4.901	2.405	1.911	.494	2.182	2.448	75.340
2	1.810	.095	13	6.283	5.686	3.142	2.573	.569	1.909	2.110	55.965
2¼	2.060	.095	13	7.069	6.472	3.976	3.333	.643	1.697	1.854	43.205
2½	2.282	.109	12	7.854	7.169	4.909	4.090	.819	1.527	1.673	35.208
2¾	2.532	.109	12	8.639	7.955	5.940	5.036	.904	1.388	1.508	28.599
3	2.782	.109	12	9.425	8.740	7.069	6.079	.990	1.273	1.373	23.690
3¼	3.010	.120	11	10.210	9.456	8.296	7.116	1.180	1.175	1.269	20.237
3½	3.260	.120	11	10.996	10.242	9.621	8.347	1.274	1.091	1.171	17.252
3¾	3.510	.120	11	11.781	11.027	11.045	9.677	1.368	1.018	1.088	14.882
4	3.732	.134	10	12.566	11.724	12.566	10.939	1.627	.954	1.023	13.164
4½	4.232	.134	10	14.137	13.295	15.904	14.066	1.838	.848	.902	10.237
5	4.704	.148	9	15.708	14.778	19.635	17.379	2.256	.763	.812	8.286
6	5.670	.165	8	18.850	17.813	28.274	25.249	3.025	.636	.673	5.703
7	6.670	.165	8	21.991	20.954	38.485	34.942	3.543	.545	.572	4.121
8	7.670	.165	8	25.133	24.096	50.265	46.204	4.061	.477	.498	3.117
9	8.640	.180	7	28.274	27.143	63.617	58.629	4.988	.424	.442	2.456
10	9.594	.203	6	31.416	30.140	78.540	72.292	6.248	.381	.398	1.992
11	10.560	.220	5	34.558	33.175	95.033	87.582	7.451	.347	.361	1.644
12	11.542	.229	....	37.699	36.260	113.097	104.629	8.468	.318	.330	1.376
13	12.524	.238	4	40.841	39.345	132.732	123.190	9.542	.293	.304	1.169
14	13.504	.248	....	43.982	42.424	153.938	143.224	10.714	.272	.282	1.005
15	14.482	.259	3	47.124	45.497	176.715	164.721	11.994	.254	.263	.874
16	15.460	.270	....	50.265	48.569	201.062	187.719	13.343	.238	.247	.767

This information supplements that on pages 419 to 459

Metric Conversion Tables

Pounds per Linear Foot to Kilos per Linear Meter

Lbs. per foot		10	20	30	40	50	60	70	80	90
				Kilos per Meter						
0	.....	14.882	29.764	44.645	59.527	74.409	89.291	104.172	119.054	133.936
1	1.4882	16.370	31.252	46.133	61.015	75.897	90.779	105.660	120.542	135.424
2	2.9764	17.858	32.740	47.621	62.503	77.385	92.267	107.148	122.030	136.911
3	4.4645	19.347	34.229	49.110	63.992	78.874	93.756	108.637	123.519	138.401
4	5.9527	20.835	35.717	50.598	65.480	80.362	95.244	110.125	125.007	139.889
5	7.4409	22.323	37.205	52.086	66.968	81.850	96.732	111.613	126.495	141.377
6	8.9291	23.811	38.693	53.574	68.456	83.338	98.220	113.101	127.983	142.865
7	10.4172	25.299	40.181	55.062	69.944	84.826	99.708	114.589	129.471	144.353
8	11.9054	26.787	41.669	56.550	71.432	86.314	101.196	116.077	130.959	145.841
9	13.3936	28.276	43.158	58.039	72.921	87.803	102.685	117.566	132.448	147.330

Kilos per Linear Meter to Pounds per Linear Foot

Kilos per meter		10	20	30	40	50	60	70	80	90
				Pounds per foot						
0	.....	6.720	13.439	20.159	26.879	33.598	40.318	47.037	53.757	60.477
1	0.6720	7.392	14.111	20.831	27.551	34.270	40.990	47.709	54.429	61.149
2	1.3439	8.064	14.783	21.503	28.223	34.942	41.662	48.381	55.101	61.821
3	2.0159	8.736	15.455	22.175	28.895	35.614	42.334	49.053	55.773	62.493
4	2.6879	9.408	16.127	22.847	29.567	36.286	43.006	49.725	56.445	63.165
5	3.3598	10.080	16.799	23.519	30.239	36.958	43.678	50.397	57.117	63.837
6	4.0318	10.752	17.471	24.191	30.911	37.630	44.350	51.069	57.789	64.509
7	4.7037	11.424	18.143	24.863	31.583	38.302	45.022	51.741	58.461	65.181
8	5.3757	12.096	18.815	25.535	32.255	38.974	45.694	52.413	59.133	65.853
9	6.0477	12.768	19.487	26.207	32.927	39.646	46.366	53.085	59.805	66.525

Metric Conversion Tables (Concluded)

Pounds per Square Inch to Kilograms per Square Millimeter

Lbs. per square inch		10000	20000	30000	40000	50000	60000	70000	80000	90000
	Kilos per square millimeter									
0000	.....	7.030	14.060	21.090	28.120	35.150	42.180	49.220	56.250	63.280
1000	0.703	7.733	14.763	21.793	28.823	35.853	42.883	49.923	56.953	63.983
2000	1.406	8.436	15.466	22.496	29.526	36.556	43.586	50.626	57.656	64.686
3000	2.109	9.139	16.169	23.199	30.229	37.259	44.289	51.329	58.359	65.389
4000	2.812	9.842	16.872	23.902	30.932	37.962	44.992	52.032	59.062	66.092
5000	3.515	10.545	17.575	24.605	31.635	38.665	45.695	52.375	59.765	66.795
6000	4.218	11.248	18.278	25.308	32.338	39.368	46.398	53.438	60.468	67.498
7000	4.922	11.952	18.982	26.012	33.042	40.072	47.102	54.142	61.172	68.202
8000	5.625	12.655	19.685	26.715	33.745	40.775	47.805	54.845	61.875	68.905
9000	6.328	13.358	20.388	27.418	34.448	41.478	48.508	55.548	62.578	69.608

Kilograms per Square Millimeter to Pounds per Square Inch

Kilos per square millimeter		10	20	30	40	50	60	70	80	90
	Pounds per square inch									
0	......	14223	28446	42670	56893	71116	85339	99563	113786	128009
1	1422	15645	29868	44092	58315	72538	86761	100985	115208	129431
2	2845	17068	31291	45515	59738	73961	88184	102408	116631	130854
3	4267	18490	32713	46937	61160	75383	89606	103830	118053	132276
4	5689	19912	34135	48359	62582	76805	91028	105252	119475	133698
5	7112	21335	35558	49782	64005	78228	92451	106675	120898	135121
6	8534	22757	36980	51204	65427	79650	93873	108097	122320	136543
7	9956	24179	38402	52626	66849	81072	95295	109519	123742	137965
8	11378	25601	39824	54048	68271	82494	96717	110941	125164	139387
9	12801	27024	41247	55471	69694	83917	98140	112364	126587	140810

This information supplements that on pages 460 to 476

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I. P. S.—Iron Pipe Size. This term is misleading, inasmuch as it is used in the fittings trade to indicate valves and fittings threaded for wrought pipe sizes (either iron or steel).

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Companion Flange.—A flange suited to connect with a fitting, valve, etc. Unless otherwise specified, to be faced only and threaded to screw on pipe, and conforming with the American Standard. When specified to be drilled, the drilling will conform to the same standard unless otherwise specified.

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Grip or Grief Pipe.—The top pipe that is engaged by rotary driving mechanism to stand the severe strain of driving a rotary drilling stem.

Page 504

Rose Head.—A sprinkler nozzle

PUBLICATIONS OF NATIONAL TUBE COMPANY

"NATIONAL" BULLETINS

"NATIONAL" Bulletins form an easily accessible source of the latest information regarding "NATIONAL" Tubular and allied products, because the Bulletins are sent free on request to anyone interested in these and like subjects. While each "NATIONAL" Bulletin is complete in itself, yet various phases of the same subject may be treated in separate Bulletins, and therefore two or more may be necessary to secure the complete information. For instance: the subjects of Corrosion, Durability and Spellerizing of "NATIONAL" Pipe are contained in more than one Bulletin.

The titles of "NATIONAL" Bulletins and their numbers are given below:

"NATIONAL" BULLETINS

No. 1—Some Recent Developments in Testing Boiler Tubes.
No. 2—Corrosion of Hot-Water Piping in Bath Houses.
No. 3—The Durability of Welded Pipe in Service.
No. 4—Corrosion of Boiler Tubes.
No. 5—"NATIONAL" Pipe for Refrigerating Systems.
No. 6—Pipe Threading Dies.
No. 7—"N. T. C." Regrinding Valves.
No. 8—"NATIONAL" Coating.
No. 9—Some Tests of "KEWANEE" Unions.
No. 10—The Relative Corrosion of Iron and Steel Pipe as Found in Service.
No. 11—History, Characteristics and The Advantages of "NATIONAL" Pipe.
No. 12—Characteristics of "NATIONAL" Pipe.
No. 13—"N. T. C." Iron Body Brass Mounted Wedge Gate Valves.
No. 14—"NATIONAL" Tubular Steel Poles.
No. 15—"NATIONAL" Pipe for Drilling Purposes.
No. 16—"NATIONAL" Stationary and Marine Boiler Tubes.
No. 17—The Manufacture and Use of "SHELBY" Seamless Tubing.
No. 18—"NATIONAL" Reamed and Drifted Pipe.
No. 19—List of Products.
No. 20—Index for "NATIONAL" Bulletins Nos. 1 to 20.
No. 21—"NATIONAL" Bedstead Tubing.
No. 22—"NATIONAL" Pipe for Railway Signal Service.
No. 23—"NATIONAL" Dry Kiln Pipe.
No. 24—The Rise of Steel Pipe.
No. 25—"NATIONAL" Pipe in Large Buildings.
No. 26—Autogenous Welding of "NATIONAL" Pipe.

"NATIONAL" Bulletin Summary

In addition to "NATIONAL" Bulletins, this Company also publishes from time to time other types of informatory literature (see list following) which may also be secured free of charge on request by those whose letter-head or activities would indicate a legitimate use. There is one exception only, THE BOOK OF STANDARDS, for which there will be a charge of two dollars.

"NATIONAL" Pipe

MODERN WELDED PIPE. Book of 32 pages (7¾x8¾), profusely illustrated with nearly thirty halftone and line engravings; also description of the manufacture, properties and durability of "NATIONAL" Pipe. There are various tables covering summary of results of investigations on the comparative corrosion of iron and steel in actual service, with many conclusive opinions from experts who have conducted numerous searching investigations and tests. (Edition exhausted; another being prepared.)

STANDARD BUNDLING SCHEDULE FOR "NATIONAL" PIPE. Card (6x6½, folded to 3x6½), 2 illustrations. Contains table showing number of pieces per bundle, average length and average weight of Standard "NATIONAL" Pipe, "NATIONAL" Extra Strong Pipe, and "NATIONAL" Double Extra Strong Pipe; sizes ⅛ inch to 1½ inch, inclusive.

"NATIONAL" Pipe—Continued

STRUCTURAL DIFFERENCES. Circular, single sheet (8½x11), illustrated with two micro-photographs showing the structure of "NATIONAL" Pipe and wrought iron pipe. The description proves conclusively, when compared with the photographs, that "NATIONAL" Pipe is homogeneous, or uniform in structure, while wrought iron pipe is hetrogeneous, or non-uniform. A list of the advantages of "NATIONAL" Pipe is also included.

"NATIONAL" PIPE. Circular, single sheet (8½x11), contains brief explanation of the process of Spellerizing, and the special advantages to the smaller sizes of "NATIONAL" Pipe (4 inches and under) of this roll-knobbling process, to which "NATIONAL" Pipe ONLY is subjected. If pipe is not "NATIONAL" it is NOT Spellerized.

FROM ORE TO FINISHED "NATIONAL" PIPE. Folder, 8 pages (8½x11), 6 illustrations. Contains description of three reels of motion pictures showing the manufacture of "NATIONAL" Modern Welded Pipe.

FROM ORE TO FINISHED "NATIONAL" PIPE. Booklet, 12 pages (4¼x9¼) and cover, 11 illustrations. In addition to brief description of the motion pictures showing the manufacture of "NATIONAL" Modern Welded Pipe, this booklet contains short explanatory articles on the butt-weld and lap-weld processes of making pipe and the subject of Pipe Threading; also excerpts from the writings of several recognized authorities on the relative durability of steel and wrought iron pipe, concluding with a summary of "NATIONAL" Bulletins, Nos. 1 to 19, inclusive.

"NATIONAL" BULLETIN No. 11—HISTORY, CHARACTERISTICS AND THE ADVANTAGES OF "NATIONAL" PIPE (48 pages, 53 halftones, 51 zinc etchings). This Bulletin contains interesting information relative to the history of pipe and its manufacture with particular reference to "NATIONAL" Pipe, together with authenticated data on service tests. The text is arranged under the following heads: A Short History of Pipe and Early Methods of Manufacturing, First American Pipe Furnaces, History of National Tube Company, Material for Pipe, The First Steel Pipe, Pipe Threading, Spellerizing "NATIONAL" Pipe, Full Standard Weight Pipe Only Manufactured, The Continuous Uniformity of "NATIONAL" Pipe, Physical Properties, Remarkable Ductility of "NATIONAL" Pipe, Bursting Pressure, The Inspection and Tests of "NATIONAL" Pipe, Changes in the Tubular Industry, "NATIONAL" Pipe for Refrigerating Systems, Corrosion of Pipe in Hot Water Systems, The Design of Hot Water Supply Systems to Minimize Corrosion, Corrosion of Pipe in Coal Mines, Corrosion of Pipe in General Service, Corrosion of Pipe in Green House Service, "NATIONAL" Pipe for Gas Lines, Corrosion of Pipe in Boiler Feed-water Service, Relative Corrosion of Iron and Steel Pipe for Plumbing Service, A Summary of Results of Investiga-

"NATIONAL" Pipe—Continued

tions of the Corrosion of Iron and Steel Pipe in Actual Service, Corrosion of Iron and Steel Pipe Under Atmospheric Conditions, Diagrammatic Representations of the Merits of "NATIONAL" Pipe compared to Wrought Iron and Ordinary Steel Pipe with references, and a summarized list of "NATIONAL" Bulletins Nos. 1 to 23, inclusive.

"NATIONAL" BULLETIN No. 12—CHARACTERISTICS OF "NATIONAL" PIPE (20 pages, 7 illustrations). This Bulletin contains a summary of information in regard to "NATIONAL" Pipe. The data is supplied under the following headings: Steel Pipe, Uniformity, Physical Properties, Chemical Composition, Bursting Strength, Improvements, Full Weight Pipe, Spellerizing, Threading, Corrosion (résumé of opinions), Specifications, Metallurgical Department, Literature, Summary of Advantages, List of Uses of "NATIONAL" Pipe, List of Publications issued by National Tube Company, and charts showing increase in manufacture of steel pipe from 1887 to 1913.

"NATIONAL" BULLETIN No. 15—"NATIONAL" PIPE FOR DRILLING PURPOSES (8 pages, 6 halftone illustrations). This Bulletin contains a full description of this product, the information being supplied under the following captions: Process of Manufacture, Material, Physical Properties, Bending Tests on Welded Pipe, Internal Pressure Test, Length, Permissible Variations, Upsetting, Threading and Reaming, Couplings, Marking, Finish, Inspection, Galling of Threads, Strength of Joint, Torsional Tests with Tables, "NATIONAL" Drill Pipe with Table, "NATIONAL" Special Rotary Pipe with Table, "NATIONAL" Special Upset Rotary Pipe with Table, "NATIONAL" Seamless Interior Upset Drill Pipe with Table, Precautions in Handling Drill Pipe and Trade Customs.

"NATIONAL" BULLETIN No. 18—"NATIONAL" REAMED AND DRIFTED PIPE (12 pages, 33 halftone illustrations). This Bulletin contains a complete description of this product with a short introduction explaining the process of Well Drilling and information relative to the various accessories necessary for the drilling and pumping of wells. For example—Well Cylinders, Points, Valves, Strainers, Drive Shoes, Couplings, Drive Caps, Seating Tool, etc.

"NATIONAL" BULLETIN No. 19—LIST OF PRODUCTS (8 pages). To supply a quick and ready reference is the purpose of this Bulletin. The products manufactured by this Company are designed for a great variety of mechanical and commercial purposes, hence a single catalogue containing a detailed description of each separate product would be cumbersome. This Bulletin contains a concise list, which gives to the trade reliable information about National Tube Company products.

"NATIONAL" BULLETIN No. 20—INDEX FOR "NATIONAL" BULLETINS Nos. 1 to 20 (82 pages, 6 illustrations). This Bulletin is a cross-indexed guide to the information contained in all "NATIONAL" Bulletins from 1 to 19, inclusive.

"NATIONAL" Pipe (Continued)

"NATIONAL" BULLETIN No. 21—"NATIONAL" BEDSTEAD TUBING (8 pages, 10 illustrations). This Bulletin gives much information and data, and shows the advantages of using "NATIONAL" Tubing in the manufacture of modern steel beds, cribs, bungalow beds, bed springs, costumers, etc., and a list of "NATIONAL" Bulletins, Nos. 1 to 19, inclusive.

"NATIONAL" BULLETIN No. 22—"NATIONAL" PIPE FOR RAILWAY SIGNAL SERVICE (12 pages, 18 illustrations). This Bulletin contains a brief description of the several classes of modern railway signal systems with illustrations of a number of installations in which "NATIONAL" Pipe has been used; Standard Signal Pipe Specifications, as approved by The Railway Signal Association, October, 1910; and considerable information relative to "NATIONAL" Pipe for this character of service. This information is given under the following headings: STRENGTH: Physical Properties, Chemical Purity, Resistance. DURABILITY and THREADING QUALITIES. In addition there is a list of "NATIONAL" Bulletins, Nos. 1 to 22, inclusive.

"NATIONAL" BULLETIN No. 23—"NATIONAL" DRY KILN PIPE (20 pages, 13 illustrations). This Bulletin contains information relative to this class of "NATIONAL" Pipe and its use. The text matter is grouped under the following headings: Material Used, Method of Manufacture, Uniformity, Chemical Composition, Physical Properties, Bursting Strength, Durability (Resistance to Corrosion), Full Weight, Special Treatments (Spellerizing), Threading Properties and Tests. There are also tables giving Weights and Dimensions of "NATIONAL" Dry Kiln Pipe and Couplings and "NATIONAL" Standard Pipe—Black and Galvanized, and considerable engineering data relating to Dry Kiln work, closing with a summary of "NATIONAL" Bulletins Nos. 1 to 23, inclusive.

"NATIONAL" BULLETIN No. 24—THE RISE OF STEEL PIPE (8 pages, 4 illustrations). This Bulletin contains three editorials, covering the general subject of "The Rise of Steel Pipe," which appeared in the American Metal Market and Daily Iron and Steel Report, August 20, 1914, The Iron Trade Review, October 15, 1914, and The Iron Age, December 3, 1914. There are some comments on these editorials, together with a list of advantages of "NATIONAL" Pipe and complete summary of "NATIONAL" Bulletins Nos. 1 to 24, inclusive.

"NATIONAL" BULLETIN No. 25—"NATIONAL" PIPE IN LARGE BUILDINGS (88 pages, 222 illustrations). This Bulletin contains a brief outline of the progress of the last twenty years in building construction; a summary of the advantages of "NATIONAL" Pipe service and the value of marking manufactured products as brought out in a recent editorial in The American Architect; a short summary of the results of tests and investigations of independent authorities relative to the durability of wrought iron and steel pipe; illustrations of Banking, Financial and Office

"NATIONAL" Pipe (Continued)

Buildings, Mercantile and Industrial Buildings, Hotels, Clubs and Apartments, Universities, Colleges, Schools, Churches, Libraries and similar public buildings in which "NATIONAL" Pipe has been installed; "The Design of Hot Water Supply Systems to Minimize Corrosion," a paper by F. N. Speller, published in Engineering News, February 13, 1913; Specifications covering "NATIONAL" Standard Welded Pipe, "NATIONAL" Air Line Pipe and "NATIONAL" Special Ammonia Pipe, together with tables giving dimensions and weights; Engineering data extracted from "Book of Standards," 1913 Edition, National Tube Company, relative to piping and its use in building construction; an index to the important subjects and illustrations contained in this Bulletin and a short summary of all "NATIONAL" Bulletins Nos. 1 to 25, inclusive.

"NATIONAL" BULLETIN No. 26—AUTOGENOUS WELDING of "NATIONAL" PIPE (56 pages, 91 illustrations). This Bulletin contains information relative to the general subject of autogenous welding of "NATIONAL" Pipe; a brief statement of the advantages of "NATIONAL" Pipe for work of this character; a number of articles and papers on autogenous welding of pipe lines written by men who are acknowledged leaders and authorities in the water and gas works industry; cost and engineering data; table of contents and cross indexed guide to the important subjects covered in this Bulletin and a summary of all "NATIONAL" Bulletins from 1 to 26, inclusive.

"NATIONAL" MATHESON JOINT PIPE. Book of 72 pages and cover (7¾x10), illustrated with halftone engravings from original photographs and line drawings. There is a great amount of comprehensive information on the value of "NATIONAL" Matheson Joint Pipe, given in an interesting, non-technical style. Illustrative comparisons with cast iron pipe are made; conclusive proof of the durability during long service is given; concluding with description and illustration of "NATIONAL" Coating and table of weights and dimensions with Specifications for "NATIONAL" Matheson Joint Pipe.

"NATIONAL" MATHESON AND "NATIONAL" CONVERSE JOINT PIPE. Book of 40 pages (3½x6), illustrated with several halftone and line views of above joints and fittings. Also description of the pipe and fittings for same with tables of sizes of joints and fittings and Trade Customs. This book is known as List No. 3.

"NATIONAL" MATHESON JOINT PIPE. Circular, 4 pages (8½x11), two illustrations. The advantages of "NATIONAL" Matheson Joint Pipe are made apparent in the first two pages of this circular. Pages 3 and 4 contain interesting information relative to the advantages of "NATIONAL" Coating.

Pipe—Threading

POWER REQUIRED TO THREAD, TWIST AND SPLIT WROUGHT IRON AND MILD STEEL PIPE. Book of 24 pages (6x9), with 14 illustrations, contains a paper read by Prof. T. N. Thompson, International Correspondence School, before the American Society of Heating and Ventilating Engineers, 1906, covering the results of an extensive series of tests which he conducted to ascertain the power required to thread, twist, and split wrought iron and mild steel pipe. The tabulated information is valuable to those interested in the subject.

"NATIONAL" BULLETIN No. 6—PIPE THREADING DIES (12 pages, 21 illustrations). Because this subject is more or less misunderstood, the information contained in this Bulletin is especially valuable. The illustrations clearly demonstrate by comparison the working of a properly and improperly shaped die. The information is grouped under the following headings: "Lip," "Chip Space," "Clearance," "Lead," "Number of Chasers," "Oil," "General Summary," and an article on "Briggs' Standard Threads."

Pipe—Poles

"NATIONAL" BULLETIN No. 14—"NATIONAL" TUBULAR STEEL POLES (32 pages, 25 halftone and 2 line illustrations). This Bulletin contains a complete description of these poles, the information being supplied under the following headings: Uniformity, Lighting, Physical Properties, Joints, Dog Guards, Street Railway Poles, Painting, Pole Tables, Pole Fittings, Specifications, etc. There are also ten pages of tables giving full information in regard to size, weight, wall thickness, maximum load, deflection, etc., of "NATIONAL" Tubular Poles.

Pipe—Specifications

Uniform size (8½x11), either single or double sheets. The various types of "NATIONAL" Pipe and allied tubular products are covered by specifications which can be secured upon request.

Our Metallurgical Department is constantly at work endeavoring to improve, either in manufacturing processes or by special treatment of material, "NATIONAL" Tubular and allied products, and whenever necessary issues new specifications or makes such changes, revisions and improvements on all specifications in force as may be required by altered conditions.

Pipe—Corrosion

"NATIONAL" BULLETIN No. 2—CORROSION OF HOT WATER PIPING IN BATH HOUSES (8 pages, 2 illustrations). This Bulletin contains a report of an investigation conducted by Ira H. Woolson, M. Am. Soc. M. E., Consulting Engineer to National Board of Fire Underwriters, New York City, relative to the corrosion of iron and steel in hot-water piping in a New York bath house system. Eighty-nine samples of pipe from various bath houses were collected, and from the evidence Mr. Woolson arrived at the following CONCLUSION:

Pipe—Corrosion—Continued

"In my judgment from the evidence collected, there was absolutely no difference in the corrosion of the two classes of pipe.* They appeared to be equally susceptible to the attack."

*That is, wrought iron and steel.

This Bulletin also contains a paper on "The Design of Hot Water Supply Systems to Minimize Corrosion," by F. N. Speller, Metallurgical Engineer, National Tube Company, published in Engineering News, issue of February 13, 1913. This paper is particularly valuable in that the suggested designs tend to reduce corrosion of pipe to a minimum.

"NATIONAL" BULLETIN No. 3—THE DURABILITY OF WELDED PIPE IN SERVICE (8 pages, 2 illustrations). This Bulletin contains a paper prepared by F. N. Speller, Metallurgical Engineer, National Tube Company, read before the annual meeting of the American Society of Heating and Ventilating Engineers, and published in Engineering Review, April, 1911. This article covers considerable information relative to the durability of welded pipe as found under various conditions; also detailed notes on corrosion of wrought iron and steel pipe in service lines in over 21 separate investigations, and the net results obtained in each case are compiled and tabulated, with some notes regarding the prevention of corrosion in pipes.

"NATIONAL" BULLETIN No. 5—"NATIONAL" PIPE FOR REFRIGERATING SYSTEMS (36 pages, 27 illustrations). This Bulletin contains information relative to the several types of systems employed in refrigerating work, with a brief statement of principles upon which the two most commonly used systems are based—The Compression and Absorption systems—together with a short discourse on the relative merits of "NATIONAL" and Wrought Iron pipe for refrigerating work. In addition there are papers of general interest to all those interested in this subject—"Steel Pipe vs. Wrought Iron Pipe in Refrigerating Work" by P. DeC. Ball, and "Corrosion of Pipe in Refrigerating Systems" by F. N. Speller, considerable engineering data applying to refrigerating work and a list of "NATIONAL" Bulletins Nos. 1 to 24, inclusive.

"NATIONAL" BULLETIN No. 10—THE RELATIVE CORROSION OF IRON AND STEEL PIPE AS FOUND IN SERVICE (24 pages, 20 illustrations). This Bulletin contains abstract from a paper by William H. Walker, Ph. D., read before the New England Water Works Association, December 13, 1911, and which related in detail the results of an investigation undertaken by Professor Walker with reference to the subject indicated. Approximately 64 comparisons of iron and steel were obtained where the history of installation was known. Prof. Walker's CONCLUSION follows:

Pipe—Corrosion—Continued

"These results again demonstrate that taken on the average there is no difference in the corrosion of iron and steel pipe. Conversations held with the engineers in charge of plants during this investigation confirm the statement already made that a pipe is frequently called steel when corrosion is found to be excessive, while it is set down as iron if it rusts but little."

This Bulletin also contains several papers by F. N. Speller, Metallurgical Engineer, National Tube Company, on the relative merits of Steel and Wrought Iron Pipe.

CORROSION OF TUBES. Circular, 8 pages (8½x11), contains reprint of a chapter from the "Corrosion of Iron and Steel," by A. Sang (published by McGraw-Hill Publishing Co., New York); also a general bibliography of the more important publications covering, besides the general subject as above, special treatises on Effect of Impurities; Acid Tests; Relative Corrosions; Corrosion in Sea Water; Boilers; Structural Work and Wire. In all nearly one hundred authors and their works are mentioned.

CONCERNING STEEL AND IRON PIPE. Circular, 8 pages (8½x11), contains reference to pamphlet entitled "A Few Facts" which formed the basis for incorrect information printed in an article in Official Bulletin (August, 1910) of National Association of Steam and Hot Water Fitters. This circular corrects the inaccuracies of the article in question, and also contains other information of general interest on the subject.

THOUGHT IT WAS STEEL BUT IT WASN'T. Circular, 4 pages (5x7½); 3 illustrations. Relates suggestive incident showing that identity of iron and steel are frequently confused.

THE DESIGN OF HOT WATER SUPPLY SYSTEMS TO MINIMIZE CORROSION. Circular, single sheet (8½x11). (An article by F. N. Speller, Metallurgical Engineer of National Tube Company, published in Engineering News, February 13, 1913.) Contains explanation with illustrative diagrams of the Underfed Closed and Overhead Open Systems of Hot Water Supply Systems and comparative results obtained from a series of research tests and investigations of each type. This article is also reproduced in "NATIONAL" Bulletins Nos. 2 and 11.

Pipe—Miscellaneous

"NATIONAL" BULLETIN No. 8—"NATIONAL" COATING (8 pages, 11 illustrations). This Bulletin describes in detail the modern method of protecting underground piping systems against external corrosion and electrolysis, known as "NATIONAL" Coating. The headings indicate the scope of the information: "Necessity for Protection Other than that Afforded by the Use of Good Steel," "Process of Applying 'NATIONAL' Coating," "Summarizing the Advantages of 'NATIONAL' Coating," "Suggestions Regarding the Laying of Pipe Covered with 'NATIONAL' Coating," "Specifying."

Pipe—Miscellaneous—Continued

COLLAPSING PRESSURES OF LAP-WELDED STEEL TUBES. Book of 95 pages (6x9), illustrated with numerous line drawings, photographs, charts, etc., by Prof. R. T. Stewart, University of Pittsburgh. The original article was read before the American Society of Mechanical Engineers, 1906, and deals with external pressure as applied to steel tubes. There are many valuable tables in the book showing scale of collapsing pressures; also brief discussion which followed the reading of Prof. Stewart's paper.

NET PRICES OF "NATIONAL" WROUGHT PIPE BASED ON PRICE LIST No. 5 (Revised and adopted January 1, 1913). Booklet of 205 pages and cover (4½x6). Contains tables of net prices per foot of Standard, Extra Strong, Double Extra Strong, and Line Pipe at stated discounts, based upon Price List No. 5. Contains also tables of compound discounts reduced to simple discouuts and nets. (10th Edition).

PIPE LIST No. 5. 16 pages (4x6½). Booklet containing sizes, dimensions, weights, list prices, etc., and trade customs.

LIST No. 5. 44 pages (4x6½). Booklet containing sizes, dimensions, weights and list prices of tubular products and trade customs.

"NATIONAL" BULLETIN No. 10—LIST OF PRODUCTS (8 pages). To supply a quick and ready reference is the purpose of this Bulletin. The products manufactured by this Company are designed for a great variety of mechanical and commercial purposes, hence a single catalogue containing a detailed description of each separate product would be cumbersome. This Bulletin contains a concise list, which gives to the trade reliable information about National Tube Company products.

WHEN YOU ORDER BE SURE TO SPECIFY "NATIONAL" PIPE. Circular, single sheet (8½x11). Contains a reprint of an editorial, of interest to all who specify pipe for any purpose, appearing in the October 1, 1913, issue of The American Architect, under the title "Selection of Trade-Marked or Definite Building Materials."

Literature Relative to Boiler Tubes

MODERN BOILER TUBE. Book of 40 pages and cover (7¾x8¾), with 4 illustrations. Contains brief introduction covering material, tests, specifications and summary of data presented at the International Master Boiler Makers' Association Conventions, 1909, 1910 and 1911; followed by twenty-six pages of the Official Report of Special Committee on "Steel vs. Iron Flues," International Master Boiler Makers' Association Convention, held at Louisville, Ky., April 27-30, 1909.

"NATIONAL" BULLETIN No. 1—SOME RECENT DEVELOPMENTS IN TESTING BOILER TUBES (8 pages, 7 illustrations).

Literature Relative to Boiler Tubes—Continued

This Bulletin contains a paper prepared by F. N. Speller, Metallurgical Engineer, National Tube Company, and presented at Fourteenth Annual Meeting American Society for Testing Materials, Atlantic City, N. J., June 27th to July 1st, 1911. The test applied to each "NATIONAL" Spellerized Steel Locomotive Boiler Tube is described in full. Briefly, this test is made on the two crop ends from each tube; whereby a special manipulation test is given, containing in one piece the vertical crushing, horizontal flattening, expanding and flanging tests. This Bulletin also contains Standard Specifications for Lap-Weld and Seamless Steel Boiler Tubes, Safe Ends and Arch Tubes (including Super-heater Tubes), as jointly recommended and adopted in 1913 by the American Railway Master Mechanics' Association, and the American Society for Testing Materials. A summary of data relative to Steel vs. Iron Flues and Tests applied to "NATIONAL" Boiler Tubes is also included.

SPECIFICATIONS. Uniform size (8½x11), either single or double sheets. The various types of "NATIONAL" Pipe and allied tubular products are covered by specifications which can be secured upon request.

Our Metallurgical Department is constantly at work endeavoring to improve, either in manufacturing process or by special treatment of material, "NATIONAL" Tubular and allied products, and thus whenever necessary issues new specifications or makes such changes, revisions and improvements on all specifications in force as may be required by altered conditions.

"NATIONAL" BULLETIN No. 16—"NATIONAL" STATIONARY AND MARINE BOILER TUBES (12 pages, 8 halftone illustrations). This Bulletin contains a description of these boiler tubes with illustrations of tests. The information is supplied under the following heads: Reasons for Manufacturing Only Steel Tubes, Spellerizing, Material, Physical Properties, Inspection, Physical Tests, Opinions of Experts, etc. Several pages of engineering data on Boiler Incrustation and Corrosion, Steam, etc., are included.

"NATIONAL" BULLETIN No. 4—CORROSION OF BOILER TUBES (12 pages, 33 illustrations). This Bulletin contains an abstract from a paper on "Corrosion of Boiler Tubes," covering a report of results obtained in an investigation by Rear Admiral John D. Ford, U. S. N., member and President of the American Society of Naval Engineers. The entire report was published in the Journal of American Society of Naval Engineers, May, 1904, and from it the abstract for this Bulletin was taken. The report covers a very full investigation relative to the comparative corrosion of wrought iron and steel boiler tubes. The tests continued over a period of 64 weeks. This Bulletin contains several tables of summaries of results, which indicate least, greatest and average loss in grammes per square inch. Also summary of various corrosion tests of wrought iron and steel, and particularly a table showing summary of results of investigations. Several different and independent investigations are referred to, giving

Literature Relative to Boiler Tubes—Continued

date, locality, length of time of service, authority of test, number of cases on record, reference to details, remarks, etc., etc.

ABOUT STEEL BOILER TUBES. Circular, single sheet (8½x11), contains information regarding economy of Steel Boiler Tubes, based on report of Committee to 1910 Convention of International Master Boiler Makers' Association.

LIST No. 5. 44 pages (4x6½). Booklet containing sizes, dimensions, weights and list prices of tubular products and trade customs.

BOILER TUBE LIST No. 5. 16 pages (4x6½). Booklet containing sizes, dimensions, weights, list prices and trade customs.

THOUGHT IT WAS STEEL, BUT IT WASN'T. Circular of four pages and three interesting illustrations from actual photographs of a piece of badly corroded boiler tube, which was tagged "Spellerized Steel" and sent as a "sample" to the Master Mechanic of an Eastern Railway System. Chemical analysis proved the "sample" was *Charcoal Iron* and *not steel.*

"SHELBY" Seamless Tubing

"SHELBY" SEAMLESS TUBES and THEIR MAKING. Book of 48 pages and cover (7¾x8¾), profusely illustrated with fine halftone engravings from original photographs. Contains, besides an interesting early history of the industry, a non-technical description of manufacture, mechanical uses and possibilities of "SHELBY" Seamless Tubing. (Enlarged and revised edition being prepared.)

SEAMLESS TUBING FOR AUTOMOBILES. Booklet of 16 pages and cover (5x9), with six illustrations showing adaptations of "SHELBY" Tubing for automobile parts, etc., with description and other useful information.

"NATIONAL" BULLETIN No. 17—THE MANUFACTURE AND USE OF "SHELBY" SEAMLESS TUBING. (44 pages, 25 halftone plates and 5 pages of line engravings, showing various manipulations of "SHELBY" Seamless Tubing). This Bulletin contains extracts from an address to the U. S. Naval School of Marine Engineering (prepared by Messrs. J. H. Nicholson and Emil Holinger) and covers the following subjects: Processes of Manufacture; Materials for Steel Pipes; Making of Specifications; Mill Inspection; Application of Tubular Sections to Machine Design and Descriptions of the Halftone Plates.

THE "SHELBY" COLD-DRAWN TROLLEY POLE. Circular, 4 pages (4¾x7¼), 4 illustrations, one of these showing the testing machine and method of making the test to which every pole is subjected before shipment.

"SHELBY"* Seamless Tubing—Continued

"SHELBY" SEAMLESS COLD-DRAWN TROLLEY POLES. Booklet of 16 pages and cover, seven illustrations. Contains considerable information relative to material, manufacture, tests, etc., with table showing loads and deflections of varying lengths.

SPECIFICATIONS. Uniform size (8½x11), either single or double sheets. The various types of "SHELBY" Tubing and allied tubular products are covered by specifications which can be secured upon request. Our Metallurgical Department is constantly at work endeavoring to improve, either in manufacturing processes or by special treatment of material, "SHELBY" tubular and allied products, and thus, whenever necessary, issues new specifications or makes such changes, revisions and improvements on all specifications in force as may be required by altered conditions.

MECHANICAL PROPERTIES OF "SHELBY" SEAMLESS TUBING. Booklet of 100 pages and cover (4½x7) with over 50 line illustrations, by Prof. Reid T. Stewart, contains useful data and tables for the solution of problems arising in connection with the application of "SHELBY" Tubing to the Mechanical Arts. Edition exhausted but information contained is incorporated in 1913 edition of "Book of Standards."

"SHELBY" SEAMLESS TUBING FOR MECHANICAL PURPOSES. (List 102, 1909). Booklet of 32 pages and cover (3¾x6). Contains list prices, sizes, gauges, trade customs, etc., and some general information regarding this product.

LIST OF PRODUCTS, "NATIONAL" Bulletin No. 19 (see Pipe—Miscellaneous.)

"SHELBY" SEAMLESS TEMPERING POTS. Circular, single sheet (8½x11). Three illustrations, also three line cuts showing weights and dimensions. Contains considerable information about the process of manufacture and the advantages gained thereby over cast iron or cast steel tempering pots.

Fittings and Valves—General

CATALOGUE J-1915. Contains the latest information relative to NATIONAL TUBE COMPANY Fittings and Valves with a small section devoted to "NATIONAL" Pipe.

This book contains 448 profusely illustrated pages (5½x7¾), grouped in 12 sections as follows:

Section 1—"NATIONAL" Pipe and Couplings, Wrought Fittings, etc.
Section 2—Drive Well Points and Well Supplies.
Section 3—"N. T. C." Malleable Iron Fittings.
Section 4—"KEWANEE" Unions and Specialties.
Section 5—"N. T. C." Cast Iron Fittings.
Section 6—Standard Brass Valves.

Section 7—Radiator Valves.
Section 8—Brass Cocks and Fittings.
Section 9—Blast Furnace Fittings, "NATIONAL" Matheson and "NATIONAL" Converse Lock Joint Fittings, Iron Cocks.
Section 10—Iron Body Valves.
Section 11—Iron Body Gate or Straightway Valves.
Section 12—Wrought Tube Radiators.

Like its predecessor, this book represents a very considerable outlay of money, not merely for printing, for this is a lesser expense than the accumulation and revision of the large amount of material this catalogue contains.

Therefore, it is a book to be given conservatively and only to those in the industry whose positions would indicate a legitimate use for the information contained in National Tube Company CATALOGUE J-1915.

"KEWANEE" Unions

"NATIONAL" BULLETIN No. 9—SOME TESTS OF "KEWANEE" UNIONS (8 pages, 5 illustrations). This Bulletin contains a full description of several special tests made on "KEWANEE" Unions, including the following: Expansion Test of "KEWANEE" Unions, with tabulated details; Air Test Under Water of "KEWANEE" Unions (the test to which every individual "KEWANEE" Union is subjected before leaving the factory), with illustrations; Service Test on "KEWANEE" Unions (illustrations of two "KEWANEE" Unions which were disconnected and reconnected over 1000 times and remained tight at the end of the test). The headings indicate something of the information given: "Inspection and Tests," "Construction," "Three Solid Parts," "Brass to Iron Thread Connection at the Ring," "Patterns," "Summary of Advantages."

THE "KEWANEE" UNION. Circular, 4 pages (5x7½), 5 illustrations. Comprehensive information about this union is given in the form of question and answer interview.

"KEWANEE" UNION (Male and Female Pattern). Circular, 4 pages (5x7½), 2 illustrations. Besides general information relative to the value of the M & F pattern, the particular economy resulting from its use is demonstrated arithmetically.

"SIGHT UNSEEN." Folder, 3 illustrated pages and flap (6x3½), contains information about "KEWANEE" Unions.

"KEWANEE" UNION STANDARD GATE VALVES. Circular of 4 pages (5x7½) and 2 illustrations explaining the special advantages of this type of valve. This information is given under the following headings: Type, Compactness, Elimination of Joints, Construction, Low Friction Losses, Weight, Tests, Easy to Remove, Other Advantages and "KEWANEE" Union Advantages. All types of "N. T. C." Brass Valves can be furnished with "KEWANEE" Union attachment.

"KEWANEE" Specialties

THE WHOLE "KEWANEE" FAMILY. Book of 72 pages (5x7½), end sheets and cover, nearly every page illustrated. In addition to tables showing sizes and list prices, etc., there is much interesting information relative to the proved value of the "KEWANEE" Union and other "KEWANEE" Specialties as contained in the testimony of actual users. Several pages are devoted to the design and advantages of "N. T. C." Regrinding Valves. A valve of this type has been opened and closed over three million times, while in regular service on a "KEWANEE" Union testing machine. The final section of this valuable book contains a summary of all "KEWANEE" Specialties, a list, with a brief summary of contents, of all publications of National Tube Company, and a complete index. This is the latest edition and contains almost three times as many pages as the first edition.

"NATIONAL" FLANGE UNION. Circular, 4 pages (5x7½), 4 halftone illustrations. Contains description of this type of flange union, which is primarily designed for severe service.

"KEWANEE" FLANGE UNION. Circular, 4 pages (5x7½), 4 illustrations. Contains description of this fitting, and its durability in service, even when the pipes are somewhat out of alignment.

"KEWANEE" AIR PUMP UNION. Circular, 4 pages (5x7½), 1 illustration. Contains description of this fitting, which is especially designed to protect in service the air pumps on locomotves.

"KEWANEE" BOILER COUPLING. Circular, 4 pages (5x7½); 2 illustrations. Contains description of this fitting, advantages of uses, also sizes and list prices.

"KEWANEE" UNION SWING CHECK VALVE. Circular, 4 pages (5x7½), seven illustrations. Contains description and details of advantages; also sizes and list prices. The particular economy of this valve is thoroughly brought out in THE WHOLE "KEWANEE" FAMILY booklet.

"N. T. C." Regrinding Valves

"NATIONAL" BULLETIN No. 7—"N.T.C." REGRINDING VALVES (8 pages, 11 illustrations). The particular advantages of this type of valve are described in detail in this Bulletin. Three illustrations show a valve, from photographs taken at three different angles, which was opened and closed 327,094 times. The valve was then reground and after being opened and closed over three million times is still in service. The various headings will afford some idea of the value of the contents: "Durability," "Construction," "Types of Discs," "Bonnet," "Body," "Bonnet Ring," "Stem," "Packing Under Pressure," "Packing Gland," "Metal," "Lift," "Wheel," "Testing," "Working Pressure," "Pattern" and "General Summary."

"N.T.C." REGRINDING VALVES. Booklet of 16 pages and 4 illustrations, including sectional view with reference figures. There is an

"N. T. C." Regrinding Valves—Continued

abundance of information given in the popular question and answer form, written in a clear, non-technical style, closing with a brief summary of the special advantages of this type of valve.

Fittings and Valves—Miscellaneous

"NATIONAL" BULLETIN No. 13—"N.T.C." IRON BODY BRASS MOUNTED WEDGE GATE VALVES (12 pages, 21 halftone and 8 line illustrations). Contains complete information in regard to this new line of wedge gate valves.

"NATIONAL" SPRING PLUG COCK. Circular, 4 pages (5x7½) illustrated. Contains description of design and special advantages in service over the ordinary cock.

DRIVE WELL POINTS and WELL SUPPLIES. Booklet of 52 pages and cover (5½x7¾), 28 of these pages are illustrated with half-tone engravings of well points, cylinders, strainers, valves and fittings, etc., etc. Tables of sizes, dimensions, list prices are also shown, with considerable general information. (Edition exhausted; another being prepared.)

RADIATORS and RADIATOR VALVES. Booklet of 26 pages and cover (3½x5¾), with 19 illustrations. Contains description of Wrought Tube Radiators and Radiator Valves, etc., with sizes and list prices, and other information on this material. (Edition exhausted; new one being prepared.)

"N.T.C." FLAT BEAD MALLEABLE FITTINGS. Circular, 4 pages (5x7½), with 23 illustrations and 2 graphic charts which show the uniform proportions of this line of fittings. The advantages to be gained by using "N.T.C." Flat Bead Malleable Fittings are clearly explained.

LIST OF PRODUCTS—"NATIONAL" Bulletin No. 19. (See Pipe—Miscellaneous.)

MEMORANDUM

Mill Practice—Measurement of Pipe

ON orders calling for commercial sizes of pipe which are finished with threads and couplings, in sizes $\frac{1}{8}$ inch to 12 inches inclusive, and where orders specify quantity in lineal feet, it is understood that random lengths fitted with threads both ends and coupling one end will be shipped and the measurement is charged from end to end, that is over-all including coupling.

If cut lengths of any sizes are ordered instructions must appear on the face of the order whether plain ends, threads only or threads and couplings are required. The mill then cuts the pipe proper to the length specified for plain ends and threads only, but if cut lengths with threads and couplings are specified the practice is the same with the exception that the couplings are charged separately, whether they are shipped loose or screwed on the pipe.

On larger sizes; namely, 14 inch O. D. and larger, information must appear on the order as to whether plain ends, threads only or threads and couplings are required, inasmuch as these large sizes are customarily held in stock in plain ends, subject to order as to the necessary requirements in regard to threads only or threads and couplings.

In figuring on lineal feet of pipe required for laying long lines, customer should make allowance when figuring on pipe fitted with threads and couplings for the distance that pipe is screwed into coupling when assembling in the field—the customary allowance being one-half the length of the coupling. Customer should also make allowance for the length of joint in ordering our "NATIONAL" Lead Joint Pipe.

his information supplements that on page 21

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